CURRENCY CRISES IN THE EUROPEAN EXCHANGE RATE MECHANISM

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I alone take responsibility for errors and inaccuracies that may remain in this thesis.

ABSTRACT

The aim of the thesis is to examine the causes of currency crises. At the empirical level, the thesis sets out to examine the experience of two member countries of the ERM: Italy and France. It provides a new formal investigation of the underlying determinants of currency crises in these countries and therefore fills a gap in the applied literature on the ERM.

In contrast to existing work, the thesis uses two proxies of speculative pressure –an index of exchange market pressure and drift-adjusted realignment expectations. Another contribution of the thesis is the use a modelling methodology based on the Markov regime switching model with time-varying transition probabilities, which overcomes the main limitations of previously employed approaches. The distribution of each proxy of speculative pressure determines the two states of the foreign exchange market, defined as normal (i.e. credible) and crisis (i.e. speculative), whose discrete shifts are functions of economic variables.

For both currencies, the switching model satisfactorily captures the conventionally recognised episodes of speculative pressure and the influence of economic variables on currency crises. The conclusions support the view that "good" fundamentals will ensure currency stability and "bad" fundamentals will provoke the emergence of high speculative pressure (in particular in the case of Italy). A striking feature is that the estimation results vary according to the crisis proxy employed. Interestingly, it appears that the index of exchange market pressure performs better than the estimated realignment expectations.

On the theoretical side, political factors -albeit widely discussed- are generally not accounted for in existing currency crisis models. An important contribution of the thesis is the development of an optimising currency crisis model that allows the presence of partisan parties to affect the determination of its equilibria. It is showed analytically that the more likely it is that the party which is soft on unemployment will be elected, the more inevitable the crisis is. The empirical analysis suggests that crises are more likely when there is a general election in France, but no conclusive evidence is found that other political factors are a key feature in the determination of the French and Italian crises.

Chapter 1
Introduction

In March 1979, France, Germany, Italy, Belgium, Luxembourg, Denmark, Ireland, the UK and the Netherlands all joined the European Monetary System (EMS) and its core arrangement, the Exchange Rate Mechanism (ERM) (except for the UK), with the objective of creating a zone of monetary stability, by promoting lower inflation and limiting currency fluctuations.

Participating countries agreed on bilateral central parities against the official basket of all currencies in the EMS, the European Currency Unit (ECU), and a band of fluctuation was established at +/-2.25 percent around the respective central ECU parities[1]. Realignment of the central parities was allowed, subject to the consent of the monetary authorities of the member countries. Moreover, there was an obligation for both the central banks of the countries concerned to intervene without limits at the fluctuation margins to defend the weak currency, with the help of credit facilities.

Most of the literature agrees on dividing the history of the ERM into three periods[2], according to the resolve of its members to achieve currency stability. Due to the frequent and large realignments between 1979 and 1983, the ERM was initially considered as a crawling peg. From 1983 until 1987, however, there were fewer and smaller adjustments of the parities and the commitment to exchange rate stability became much more significant. Finally, the Basle-Nyborg Agreement in 1987 marked a fundamental progression in the commitment to stability.

Thereafter, the way the currencies were defended clearly changed from heavy interventions to a larger use of interest rate changes and to more fluctuation of the exchange rates within the band. As a direct consequence of the ERM members' wish to fix exchange rates more permanently, the system operated entirely without realignment for a period of over five years. This leaves us to question why, after a number of years which should have made the ERM members' determination clear, September 1992 saw

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[1] Italy and Ireland were an exception with a larger, six percent fluctuation band until January 1990.

the exit of Sterling and the Italian lira from the ERM, and subsequent speculative pressure in 1993 which resulted in the introduction of wider bands.

In order to introduce the thesis, it is necessary to have a clear understanding of the causes of currency crises or, at least, of the explanations given for them. There are essentially two strands of theory, called first and second generation models. The first examines the consequences of inconsistent policies, such as excessive credit expansion, that provoke a depletion of reserves and make a devaluation inevitable. In the second, abandoning a peg is ultimately a policy decision, based on the rational assessment of the costs and benefits of changing the exchange rate system. The endogeneity of this trade-off, together with the fact that expectations directly influence the government's optimisation problem, make self-fulfilling crises possible.

Since the exchange rate is a weak point in the design of macroeconomic policy decisions, it seems only legitimate to assert that research on currency crises is of the greatest importance for open-economy macroeconomics and modern macroeconomic policy. The essence of this thesis falls within this framework.

1. 1. Motivation and Research Aims

The motivation for this thesis is a combination of facts and questions. The second generation theoretical approach to currency crises emerged following the "virtual collapse" of the European Exchange Rate Mechanism in 1992/1993. More recently, the interest and need to explain the crises theoretically and empirically has been revived by the Latin American, Russian and East-Asian currency and financial crises. Clearly, the proposed area of research is highly topical and relatively new.

Until 1995, there was a striking disproportion between the whole panoply of theoretical models of currency crises on one side, and the unusual lack of convincing empirical work on the other. Although much empirical effort has lately gone into the issue of

[2] See for example Gros & Thygesen (1998).

foreign exchange crises, there exists only limited work on speculative attacks within the ERM as most studies focus on the more recent Latin American and East Asian crises.

Moreover, when, how and why speculative attacks should occur is still unclear and it would certainly be useful to have a method that explains currency crises so that measures could be taken to avoid them. The main question to be addressed is whether one can identify significant components of currency crises. The answer revolves, in part, around the following three points. Do market operators base their actions first and foremost on recognition of, and respect for, macroeconomic variables? If so, how and to which extent? Are changes in market expectations occasioned by the impact of political factors?

Any empirical work on currency crises raises controversial conceptual and practical issues, which mostly relate to the definition of crisis, the modelling methodology, and the choice of variables to serve as indicators. The first major difficulty in systematically distinguishing currency crises from other movements in exchange rates, interest rates and reserves, is to accommodate the concept of speculative attack into an empirical definition of crisis. In the context of the ERM, a failed attack -one that does not result in the realignment of a parity- may be characterised by massive intervention on the foreign exchange market (and therefore reserves losses) and/or by extremely high short-term interest rates. A successful attack, on the other hand, results in a realignment or an exit from the system, with a devaluation and, perhaps, even after a loss of reserves and an increase in interest rates. The issue at this stage is that, although the overlap between the two definitions of crisis is substantial, using different definitions and corresponding proxies is likely, in practice, to affect the conclusions of the empirical analysis[3]. Consequently, the approach adopted in this thesis is to examine two alternative measures of currency crises: an index of exchange market pressure and drift-adjusted realignment expectations à la Svensson, which no other study so far has compared. The design and computation of the two crisis proxies therefore constitute the initial step of the study.

[3] This will become obvious in the review of the empirical literature in Chapter 2.

Although different versions may be explored within the theory of currency crisis, all models claim that the public perceives a link between the cost of defending the currency -and thus the probability of a devaluation- and weak or inconsistent economic fundamentals. Hence, the main objective of this thesis is to examine the relationship between speculative pressure and a set of economic, financial and political variables by concentrating on two dissimilar ERM member countries. France and Italy are chosen because, despite being two major players in the ERM, their economies and currencies have exhibited very distinct features[4]. Moreover, the thesis considers exogenous variables advocated by both the first and second generation currency crisis models. One of the novel contributions of this study, therefore, is to fill a gap in the empirical literature and to advance our understanding of the causes of currency crises.

In seeking to determine the origins of the recent crises, a number of researchers opt for two-step explanatory empirical models. They first identify crisis and tranquil episodes on the basis of a wide array of information variables, and then use various methodologies -in particular probit or logit models and comparisons of variables pre- and post-crisis- to predict the crisis timing or cross-country incidence. These studies suffer two main limitations that are overcome by the modelling methodology employed in this thesis, a Markov Regime-Switching model with Time-Varying Transition Probabilities, which so far has hardly been used in the literature on currency crises. Firstly, whilst the dating of tranquil and crisis episodes relies on arbitrary threshold criteria in most existing work, the proposed model draws probabilistic inferences from the observed behaviour of the dependent variable to determine its state in each point in time. Secondly, whilst most studies are articulated in two steps, the switching approach allows the transition between the crisis and tranquil regimes to be functions of economic, financial and political variables, so that the timing and causes of the shifts between states are estimated simultaneously.

Another critical issue concerns the relevant indicators of currency crises. These may relate to the real sector of the economy or to the financial sector and it is thus a challenge to encompass all the potential indicators of crisis. The evolution of classic

[4] Although it would have been interesting to include the UK in the study, the fact that Sterling was a member of the ERM for less than two years make statistical inference almost infeasible.

fundamentals such as the budget deficit, domestic credit growth, current account, and inflation can be used to explain and even predict a crisis of the first generation type. In fact, one may argue that the attacks on the Italian lira and the Spanish peseta could be anticipated several months before they took place. On the other hand, explaining speculative attacks of the second type is more complex since there is no single set of variables and specific relationship on which to base modelling methodologies. Additionally, although new models and recent crises extend the number of indicators of vulnerability to speculative attacks, the latter are not substantially different from those of the first generation models. Hence, one way to distinguish empirically between the two alternative models of currency crisis is to consider excessively narrow definitions of the models and assume that they are mutually exclusive. This restrictive approach is not adopted in the thesis. Instead, the set of explanatory variables is classified between the two generations of currency crisis models in an attempt to distinguish their potentially distinct channels of influence.

At the theoretical level, second generation models imply that it is not sufficient that the fundamentals are "prone to attack" for a crisis to occur, there also needs to be a co-ordination of market expectations that a crisis will take place. This aspect of the theory has raised much criticism in the literature. A prevalent suggestion to deal with this lacuna is to incorporate political elements in both theoretical and empirical analyses of currency crises. A fundamental objective of the thesis is therefore to provide a novel investigation of the relationship between currency crises and political events.

The idea of the theoretical model is to analyse within a coherent analytical framework how the possibility that the policymaker is of either of two political groups -with differing objectives and incentives- can affect the equilibrium in a system of fixed but adjustable parities. The model brings together the second generation currency crisis theory and the partisan political business cycles theory. Finally, the thesis makes another important contribution to the literature by estimating the main hypotheses derived from the proposed model. The tests are carried out using, again, the regime-switching methodology and the same alternative dependent variables and allowing the switches between regimes to depend on dummy variables measuring political aspects such as elections and changes in government.

1. 2. Structure of the Thesis

In order to construct a suitable framework for the thesis, Chapter 2 analyses various theoretical and empirical issues in the currency crisis literature. Examination of the literature helps highlight the rationale behind the aims of the thesis, and specify exactly the areas of research worth investigation. The first and second generation theoretical strands are explained and discussed in the first part of the chapter. It is argued that the second generation of models is more relevant to the thesis principally because, within the context of the ERM, foreign exchange reserves are not crucial in the sense models of the first type assume, but also because the countries whose currencies came under attack in 1992 and 1993 did not display the economic difficulties characterised in these latter models. Second generation models differ from each other in terms of the variable policymakers focus on in their objective function. The latter can be, for example, the foreign interest rates, output, public debt, terms of trade or unemployment. Therefore, these diverse models bring to light as many potential trigger variables of currency crises on which to design empirical work.

By reviewing existing empirical contributions in detail, the second half of Chapter 2 also debates controversial technical issues. There is no unique method to study currency crises. The chapter tries to regroup them and compare their usefulness. It is pointed out that the index of exchange market pressure performs well in identifying speculative attacks in the empirical literature. A critical issue, however, is that currency crises are found to be heterogeneous in practice. The timing of the attack varies from one case to another so that the various attempts to forecast crises are sensitive to the currency and period used in the exercise. This observation has led some[5] to doubt whether speculative attacks are predictable and whether leading indicators of currency crises[6] could in fact prove misleading.

In addition to establishing a chronological background within which to study the French and Italian currency crises, Chapter 3 outlines the main events that marked the history

[5] Wyploz (1998) and Eichengreen & Rose (1998).

[6] Kaminsky, Lizondo & Reinhart (1998) and others try to determine leading indicators of currency crises.

of the ERM and its member currencies. The chapter begins with a factual description of the ERM that highlights the evolution in the nature of the system from its inception until its virtual end in 1993. It then provides a detailed informal analysis of the pre-crisis economic and political developments in specific countries. It is stressed that although the Italian lira, Spanish peseta and Sterling were believed to be overvalued, it was not the case of the other currencies that came under attack. There follows a discussion of several relevant issues. It is argued, for example, that the shock of Germany's reunification and the Bundesbank's tough stance towards inflation and intervention may have aggravated the tensions in the ERM. Finally, a brief overview of the aftermath of the 1992-93 crises reveals that, although it is often discarded in the literature, speculative pressure emerged once more within the ERM in the spring of 1995.

Chapter 4 sets out the modelling methodology used to estimate the different hypotheses of the thesis. The methodology relies on Hamilton's (1989) Markov regime switching model extended to time-varying transition probabilities. The implicit assumption is that the regime-switching model should provide valuable additional information by allowing economic and/or non-economic variables to influence the switching probabilities. The data used in the estimation is described. The chapter suggests and explains that the economic variables relevant for the determination of the currency crises include debt, unemployment, the real exchange rate, the trade balance, inflation, the ratio of monetary aggregate M2 to reserves, the German mark depreciation rate against the US dollar, and output growth.

Chapter 5 presents the empirical results of the various estimations based on the index of exchange market pressure, defined as a linear combination of the movements in exchange rates, interest rates and international reserves. The chapter examines the French and Italian experiences between 1979 and 1996, and argues that the chosen methodology provides a useful statistical characterisation of the currency crises. First, the identification of the episodes of pressure on the French franc and Italian lira coincides closely with their actual experience. Secondly, the switching model shows how foreign exchange market pressure can adequately be linked to economic variables empirically.

Chapter 6 presents an empirical analysis of an alternative measure of currency crisis: drift-adjusted realignment expectations. The drift adjustment methodology -by now widely employed in applied research on target zone exchange rates- is explained in detail. The expected future exchange rate of each currency within its respective fluctuation band is estimated and subtracted from the corresponding interest rate differential to obtain the desired variable, as proposed by Rose & Svensson (1995). Next, the chapter proceeds with the application of the switching model with Fixed Transition Probabilities to the drift-adjusted devaluation expectations, before estimating the Time-Varying Transition Probability version to identify the factors that determine switches across states.

Recent currency crisis models typically assume that the policymaker is always in a "soft" mood. That is, the peg is maintained only if the net benefit of doing so is strictly positive. Chapter 7 develops a currency crisis model that takes into account the possible uncertainty related to general elections. The introduction of a political dimension shows that a high probability that a Socialist party will be elected guarantees the occurrence of a crisis, whatever the fundamentals of the economy. By contrast, if the probability that the Socialist party is elected is low, the exchange rate regime will be abandoned only when shocks to the economy reach extremes values. Finally, there remain circumstances in which multiple equilibria may occur. These predictions are examined graphically and empirically (using the Markov switching model and political dummies).

Chapter 8 summarises the main conclusions of the thesis and suggests areas for future research.

Chapter 2

Currency Crises

2. 1. Introduction

The ERM crises during the period 1992-1993, the collapse of the Mexican peso in 1994, and the Asian crises in 1997 all revealed particular aspects of currency crises and rekindled interest in the subject. In view of these events, many economists questioned the adequacy of existing models of currency crises and the preoccupations of policymakers, economists and investors about speculative attacks has led to the development of a whole array of new challenging hypotheses. The aim of this chapter is therefore to explore the insights to be gained from the very large body of literature on currency crises.

The chapter is divided in two parts. The first part reviews the theoretical literature in order to analyse the different hypotheses on currency crises. The abundant theoretical literature on foreign exchange crises is usually classified in two generations. Initially and for a long time, economists have attributed speculative attacks to inappropriate domestic policies. Subsequently, the view has been put forward that balance of payments crises could be self-fulfilling and characterised by multiple equilibria. More precisely with the Second Generation models, the focus has turned on to the interaction between the government's continuous comparison of the net benefit of managed exchange rates and the public assessment of the government's reaction to a speculative attack.

Overall, while First Generation models provide some useful insight on currency crises, there is a strong belief that the Second-Generation theoretical approach provides a better understanding of the ERM crises. The argument is that Second-Generation models enable one to understand the problems that arise with open international markets when the government does not run out of reserves, as in the case of the 1992-1993 ERM crises when reserves and fundamentals were not the sole determinants of pressure. In fact, at the time of writing, whilst Eichengreen & Jeanne (1998) hoped the subject would have reached maturity, the literature on currency crises is moving on to its Third Generation. However, Third Generation models are associated with the so-called twin-crises -or more precisely, the Asian financial crises- which incorporate banking crises as well, and fall outside the objective of the thesis.

The second part of Chapter Two is a survey of the empirical literature. We assess existing alternative empirical approaches of currency crises and, in view of the results, contemplate the usefulness of the different theories of currency crisis. The discussion encompasses the qualitative explanations and quantitative methods, and focuses on the findings regarding the role of economic fundamentals in the crises under investigation.

The remainder of the chapter is structured as follows. The next section summarises the specific aspects of the first generation of speculative attack models. Section Three describes how second generation models differ from the first generation literature but, also, among themselves. Section Four briefly reviews the theories on contagious crises. Section Five draws conclusions on the debate between first and second generation approaches. Section Six reviews the succinct literature that relates to the characteristics of the speculative attacks on European currencies in 1992-93 and makes various hypotheses regarding the factors that triggered the attacks. This is followed by an assessment of the many different techniques employed to bring evidence on currency crises. Section Eight discusses model-based empirical work on both generations of the currency crisis literature. Finally, conclusions on the existing literature are drawn in Section Nine with the objective of highlighting particular characteristics of currency crises and offering suggestions for further research.

Part 1. Theoretical Literature

2. 2. First Generation Models of Speculative Attack

2. 2. 1. The Krugman-Flood-Garber Model

The so-called first generation approach explains how the government of a small open economy with forward looking exchange markets is forced to leave a fixed rate regime by the sudden exhaustion of reserves in a speculative attack. The first contribution to the speculative attack literature is due to Krugman (1979), where the government pursues exogenous, inappropriate policies (i.e. domestic credit expansion) -while maintaining a fixed exchange rate parity- that generate a balance of payments crisis[1].

Whilst Krugman (1979) does not provide an appropriate solution for the exact timing of a collapse, because of the non-linearities in his model, Flood & Garber (1984a) and Obstfeld (1984) later present an analytical solution to calculate, for each period, the probability of collapse in the next period. That is, the probability that domestic credit, in the next period, will be so large as to result in a discrete depreciation, should a crisis occur.

In the following, we outline the basic analytical framework of Flood & Garber (1984a) and Obstfeld (1984), as reviewed in Blackburn & Sola (1993). The assumptions of the continuous-time, monetary model of a small open economy with perfect foresight are the following. The supply of the single, tradable and perishable good (produced and consumed by the agents of the economy) is fixed. The money demand function is based on standard liquidity preference motives (equation (1)). Domestic and foreign produced goods are perfectly substitutable so that purchasing power parity holds (equation (2)). Agents may hold three types of assets: domestic money, domestic bonds and foreign bonds. Domestic and foreign currencies are not substitutable. Domestic and foreign bonds are perfectly substitutable so that the interest rate parity holds (equation (3)).

Total money supply is equal to domestic credit plus foreign exchange reserves (equation (4)). Finally, domestic credit grows at a constant exogenous rate, μ, (equation (5)) and reserves do not earn any interest.

In the following, t is the time index; M_t are nominal money balances; P_t is the domestic price level; i_t is the domestic nominal interest rate; S_t is the nominal spot exchange rate (the domestic currency price of foreign exchange); the foreign variables P^* and i^* are assumed constant; $\mathring{S}_t / S_t$ is the expected rate of currency depreciation; D_t is domestic credit and R_t is the domestic currency value of foreign exchange reserves.

$$M_t / P_t = \alpha_0 - \alpha_1 i_t \qquad \text{with } \alpha_0, \alpha_1 > 0 \tag{1}$$

$$P_t = S_t P^* \tag{2}$$

$$i_t = i^* + \mathring{S} / S_t \tag{3}$$

$$M_t = D_t + R_t \tag{4}$$

$$\mathring{D}_t = \mu \qquad \text{with } \mu > 0 \tag{5}$$

Combining equations (1) and (3) gives:

$$M_t = \beta_0 S_t - \beta_1 S_t \tag{6}$$

where $\beta_0 = (\alpha_0 - \alpha_1 i^*) P^*$ and $\beta_1 = \alpha_1 P^*$[2].

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[1] Note that Krugman (1979) -as well as the early models of currency crises stimulated by his seminal work- does not consider explicitly the government's decision process

[2] β_0 is assumed strictly positive so that money holdings cannot be negative at equilibrium.

Under a fixed exchange rate, the expected rate of currency depreciation is zero, i.e. $\overset{\circ}{S}_t = 0$, and the exchange rate is fixed at $\overline{S}$ so that equation (6) reduces to $M_t = \beta_0 \overline{S}$ or, using equation (4):

$$R_t = \beta_0 \overline{S} - D_t \tag{7}$$

Combining equations (5) and (7), it can be shown that, if the rate of domestic credit growth is excessive (i.e. if it exceeds money demand), a proportional depletion of foreign exchange reserves will ensue:

$$\overset{\circ}{R}_t = -\overset{\circ}{D}_t = -\mu \tag{8}$$

Any finite stock of reserves, in this framework, may fall down to some lower bound, $R_t = \overline{R}$, in finite time, even in the absence of a speculative attack[3]. This event is referred to as the natural collapse (i.e. either a devaluation or a switch to a floating regime will follow), and is correlated with jumps in the interest rate and exchange rate. Yet, because rational agents know that, even without speculation, a collapse will ultimately happen, they will anticipate the natural collapse in order to avoid losses at this time. That is, speculation will bring the collapse date forward. Flood & Garber (1984a) formulate a process of backward induction to determine the exact timing of the collapse. The first step is to solve for the 'shadow exchange rate'; that is, the exchange rate that would prevail, did reserves fall down to $\overline{R}$. It is assumed that the post-collapse exchange rate regime is a freely floating regime. With perfect foresight, the arbitrage condition requires that the pre-attack fixed rate should equal the post-attack floating rate. That is, if $R < \overline{R}$ speculators would not profit from purchasing the government's entire reserves, whilst if $R > \overline{R}$ speculators would experience instantaneous capital gains.

The first-order non-homogenous differential equation in S_t is obtained by substituting equation (4) -with $R_t = \overline{R}$- into equation (6), with D_t and $\overline{R}$ as the forcing variables. The general solution to this equation is:

[3] The existence of the reserve floor can be interpreted as a borrowing constraint in the sense that the central bank may not be willing to borrow too much foreign currency (and exchange it for domestic bonds). However, the value of the floor can well be negative if the government becomes a net debtor in foreign currency.

$$S_t = (1/\beta_1)\int_t^{\infty} \exp[(\beta_0/\beta_1)(t-\tau)](D_\tau + \overline{R})d\tau + A\exp[(\beta_0/\beta_1)(t-z)] \tag{9}$$

where A is an arbitrary constant and z it the date at which the speculative attack occurs. Following the terminology of Blackburn & Sola (1993), the first part on the right-hand-side of equation (9) is an economically meaningful forward-looking market fundamentals component; whilst the second term is an econometrically arbitrary self-fulfilling speculative bubbles component. To keep the model simple and be consistent with common practice, the explosive speculative bubbles is ruled out, i.e. A is set equal to zero. Substituting equation (5), $D_t = D(0) + \mu t$, into equation (9) and integrating by parts, the shadow floating exchange rate is given by:

$$S_t = \beta_1\mu/\beta_o^2 + (D_t + \overline{R})/\beta_0 \tag{10}$$

In other words, the shadow floating exchange rate depreciates steadily and proportionally to the growth rate of domestic credit: $\overset{\circ}{S}_t = \mu/\beta_0$. The exact date of the collapse, z, can be derived by setting $S(z) = \overline{S}$ in equation (10) and rearranging to get:

$$z = (\beta_0\overline{S} - D(0) - \overline{R})/\mu - (\beta_1/\beta_0) = (R(0) - \overline{R})/\mu - (\beta_1/\beta_0) \tag{11}$$

where the second equality is derived from equation (7), $\beta_0\overline{S} = D(0) + R(0)$.

Equation (11) indicates that the higher the initial stock of reserves, the lower the reserve threshold, or the lower the credit expansion rate, the later the collapse date. Without speculation, $\beta_1 = 0$ and the collapse occurs when reserves are run down to $\overline{R}$. On the other hand, the larger the effect of speculation, as given by the ratio β_1/β_0, the sooner the collapse.

A considerable literature directly draws from the Krugman-Flood-Garber basic theory. Various extensions have been proposed that include, *inter alia*, relaxing the assumptions of perfect asset substitutuality and flexible prices[4]; considering alternative post-collapse

[4] See Blackburn (1988), Flood & Hodrick (1986), and Willman (1988).

regimes (floating, or crawling peg system, or return to a fixed regime after a period of flexibility); or abandoning the assumption that agents make perfect foresight as to government policies (including endogenous policy switches, external borrowing and capital controls)[5].

The various balance of payments crisis models have substantive empirical implications. First, the basic message is that reserves must be depleted for the collapse to happen. Secondly, one must observe excessive domestic growth before the crisis. One should also see an increase in the expected domestic credit. However, the latter is unobservable and more difficult to test empirically. Additionally, if the increase in domestic credit is a response to the need to finance public debt, then fiscal imbalance should also be observed prior to the crisis (e.g. public budget deficit, increasing debt to GDP ratio). Finally, the sticky-price version of the speculative attack model suggests that there should be higher inflation, a real overvaluation of the domestic currency and a deterioration of the trade balance before the collapse.

2. 2. 2. Purely Self-Fulfilling Crises

Obstfeld (1986) presents the circumstances in which balance of payments crises may be purely self-fulfilling events, comparable to bank runs à la Diamond & Dybvig (1983). The analytical framework corresponds to the linear Krugman-Flood-Garber model outlined above. However, the parameters are restricted so as to exclude the possibility of a natural collapse; the assumption of perfect foresight is released, and shocks to domestic credit can be large enough so as to drive reserves to their limit $\overline{R}$ and force the government to abandon the pegged exchange rate $\overline{S}$[6].

The Diamond-Dybvig type of bank run is as follows. If depositors have confidence in the liquidity transformation service offered by banks, there is optimal risk-sharing

[5] Agenor et al. (1992) and Blackburn & Sola (1993) offer an up-to-date review of the theoretical and empirical literature on balance-of-payments crises.

[6] Recall that in the Krugman-Flood-Garber analysis, by contrast, it is the constantly increasing domestic-credit stock that ultimately leads to the collapse of the fixed-rate regime.

among them. However, if there is a panic attack, depositors' incentives will change and self-fulfilling expectations will result in a bank run. Likewise, Obstfeld (1986) considers two possible outcomes, reflecting the indeterminacy of equilibrium in the balance-of-payments model. In one, a self-fulfilling speculative attack may erupt when agents expect the exchange rate collapse to force the government into an inflationary domestic credit policy. It follows that the probability that the shadow exchange rate is greater than the pegged rate, $Prob(S_{t+1} \geq \bar{S})$, rather than being determined by the model, is decided by the co-ordination of the subjective beliefs of speculators. In the alternative outcome, a different equilibrium path takes place as the public expects that no collapse will ever happen. In the latter case, there is no run on the foreign reserves and no switch in the domestic credit process. Expectations are self-fulfilling and the fixed-rate regime remains in place forever with probability one.

Obstfeld (1986) therefore suggest that an exchange rate can be attacked inasmuch as the stability of a pegged exchange rate regime hinges on the anticipated response of the authorities. In other words, a currency is at the mercy of the market. If investors decide a currency peg is unsustainable, funds will run away from it and unsustainable it will be. Eichengreen et al. (1994) argue that the Maastricht Treaty provided the intrinsic reason why policy would shift in the event of an attack in 1992. "Since the country, once driven out of the EMS, might no longer qualify for EMU, it would no longer possess an incentive to pursue the policies of austerity necessary to gain entry."

A typical criticism of Obstfeld (1986) is that the mechanism by which speculators co-ordinate their expectations is assumed to be driven by exogenous uncertainty. Although this view of currency crises is prevalent in the popular press, it has not made any serious impression among economists who still debate the idea that currency crises occur in the absence of radical changes in fundamentals and/or fiscal disequilibrium. It is indeed difficult, for some, to accept that crises are entirely the fault of investors and therefore nothing can be done to prevent them.

To conclude, the main criticism of the Krugman-Flood-Garber approach and Obstfeld's (1986) model is that they depend fundamentally on a reserve constraint and therefore cannot explain how a crisis arises in a world of very high capital mobility.

2. 3. Second Generation Literature

Although the second-generation literature is not homogenous, it revolves around two basic common elements: an optimising government and a circular process leading to multiple equilibria. The majority of second generation models are tightly related to so-called Escape Clause models, which derive from the literature on time inconsistency and pre-commitment in economic policy. The principle of escape clause arrangements is that a government will restrain any inflationary penchant but may allow exchange rate flexibility in those extreme situations where it is most needed[7]. In the face of a crisis, governments should in practice borrow reserves and exercise other policy actions such as reducing monetary base adequately so as to raise interest rates to a level that will deter speculators from going short in the domestic currency. Problems nonetheless emerge in reality as governments typically refrain from defending a peg with disregard to the side effects on the rest of the economy. In the escape clause literature, policymakers can therefore decide to devalue the domestic currency in order to pursue well-defined policy goals. For example, they may want to offset the detrimental effects of shocks to competitiveness and employment as well as the impact of high interest rates upon domestic economic conditions.

The new models emphasise alternative features of currency crises (i.e. credibility, the performance of the economy, and the incentive to leave the fixed regime) and outline the interaction between the government's optimal policy function and the market participants' optimal behaviour. In this respect, exchange rate credibility becomes a function of the foreign exchange market expectations about the government's policy incentives. As Obstfeld & Rogoff (1996) phrase it: " Because unanticipated sustained increases in interest rates are so costly, the goal of a central bank in a currency crisis is to convince speculators as quickly as possible that it is not going to fold, so that interest

[7] This picture captures aspects of Stage Two of the plan for EMU.

rates can return to normal levels. If investors refuse to believe that the central bank is willing to stay the course, even the most determined short-term defence will fail. Eventually the authorities will have to sacrifice the currency peg to rescue the domestic economy."

In the benchmark model, market participants have perfect common knowledge of the macroeconomic fundamentals, which are divided in three groups. In the good equilibrium, fundamentals are sufficiently good to ensure that the authorities can successfully intervene to defend the domestic currency even if a speculative attack takes place. Conversely, the fundamentals can be so bad that the peg will be relinquished, even if the domestic currency is not attacked. Finally, for middle values of the fundamentals, the exchange rate is "ripe for attack". If the attack occurs, defending the exchange rate regime may demand policies that are too undesirable so that the authorities will abandon it, whilst if the attack does not occur, the cost of intervention can be bearable and the peg is maintained. There is thus a good -or virtuous- equilibrium in which no attack takes place and a bad -or vicious- equilibrium where a self-fulfilling crisis occurs.

According to the theory of self-fulfilling crisis, all that is needed is that the different equilibria are consistent -i.e. that speculators' beliefs about the authorities' future course of action, in the event of an attack, match the authorities' actual decision. If market participants presume that a currency will be attacked, their actions will precipitate the crisis itself; whilst if market participants believe a currency to be out of danger, they will spare it from attack, thus justifying their initial belief. In other words, expectations that, *ex-ante*, may be unjustified are, *ex-post*, validated by the outcome they are responsible for –i.e. they are self-fulfilling.

To illustrate, let us first examine Jeanne's (1997) model in which speculation may be fundamental-based *and* self-fulfilling. Assume a policymaker is in a "soft" mood with probability μ and in a "tough" mood with probability $(1-\mu)$. When in a soft mood, the policymaker will defend the exchange rate parity as long as the net benefit of doing so is strictly positive. Conversely, when the policymaker is in a tough mood, the peg will be maintained whatever happens.

The net benefit of the fixed exchange rate, B_t, is given by the following:

$$B_t = b_t - \alpha\pi_{t-1} \tag{12}$$

where b_t is the gross benefit of the fixed peg and is determined by macroeconomic variables[8], and π_{t-1} is the probability assigned by the public (in period $t-1$) that the policymaker will abandon the peg in period t. The presence of π_{t-1} in equation (12) indicates that a higher credibility (i.e. a smaller π_{t-1}) increases the net benefit of the peg.

b_t is the only exogenous variable at date t and it summarises the objective economic conditions. Assume now that the innovation in b_t is independently and identically distributed so that, denoting $\phi_t = E_t(b_{t+1})$, then:

$$\varepsilon_t = b_t - \phi_{t-1} \tag{13}$$

is characterised by the density function $f(.)$ which is continuous, symmetric[9] and strictly increasing in $]-\infty, 0[$ and strictly decreasing in $]0, \infty[$[10].

The model assumes that expectations are rational so that an equilibrium will be attained whenever the government's actions are optimal given the market expectations. Given the set up therefore, the probability of an opt-out, conditional on information available at time t, is equal to the probability that the policymaker is soft ***and*** the net benefit of the peg is negative at time $t+1$, i.e. $\pi_t = \mu P_t(B_{t+1} < 0)$. Putting equations (12) and (13) together, the circularity appears in the expectations of a realignment as follows:

$$\pi_t = \mu P_t(\varepsilon_{t+1} < \alpha\pi_t - \phi_t) = \mu F(\alpha\pi_t - \phi_t) \tag{14}$$

where $F(.)$ denotes the cumulative distribution of $f(.)$.

Henceforth, the variable ϕ_t -thereafter called the fundamental- summarises all the exogenous state variables that matter for the determination of the probability that a realignment will be opted for at time $t+1$. Because both sides of the equation increase with the realignment probability, multiple equilibria are possible since the same level of the fundamental -and thus the shock to the economy- will be consistent with more than one value of the devaluation probability.

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[8] Jeanne illustrates the model using unemployment.

[9] That is, $f(\varepsilon)$ $f(-\varepsilon)$

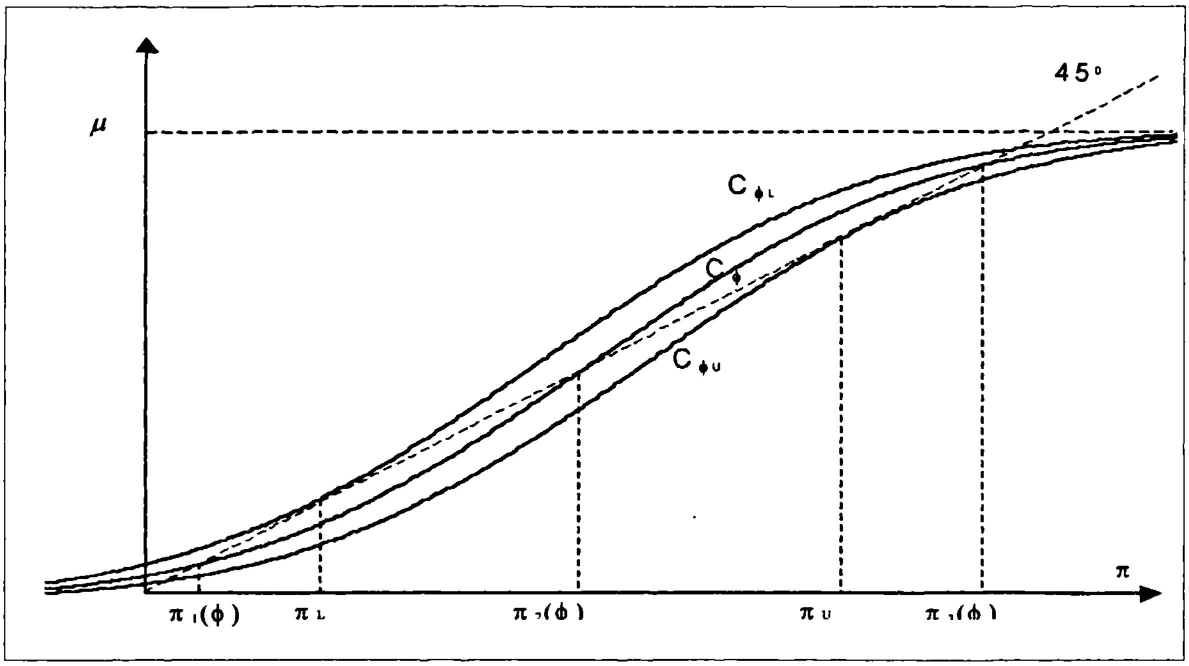
Jeanne's (1997) proposition regarding the conditions under which multiple equilibria arise is based on the graphical representation of equation (14) in Figure 1[11]. The left-hand-side of equation (14) is represented by the 45° line, and the right-hand-side corresponds to the curve C_ϕ. The slope of C_ϕ is equal to $\mu\alpha f(d\pi - \phi)$ and -given the assumptions made about $f(.)$- reaches its maximum at $\pi = \phi / \alpha$, where it is equal to $\mu\alpha f(0)$. So,

if $\mu\alpha f(0) < 1$, the probability of a realignment π is uniquely determined by the fundamentals and strictly decreasing with the values of ϕ.

if $\mu\alpha\gamma f(0) > 1$, the C_ϕ curve may intersect the 45° line in three points, if it is neither too much to the left nor to the right, i.e. there exist two critical values of ϕ, $\phi_L < \phi_U$, such that :

- when $\phi < \phi_L$, or $\phi > \phi_U$, π is also uniquely determined by the fundamental, ϕ, and strictly decreasing with ϕ.
- but when $\phi \in]\phi_L, \phi_U[$, π may take three different values, that are $\pi_1(\phi) < \pi_2(\phi) < \pi_3(\phi)$.

Figure 1: Graphical Representation of Multiple Equilibria



[10] A wide class of bell shaped density functions -including the normal distribution- satisfy these assumptions.

In summary, multiple equilibria arise if two conditions are fulfilled. The first, $\mu\alpha f(0) < 1$, refers to the structural parameters of the model whilst the second, $\phi \in]\phi_L, \phi_U[$, is associated to the time-varying fundamental. Ultimately, therefore, if the fundamental is good, $\phi > \phi_U$ (e.g. if unemployment is low, the trade balance is healthy and real exchange rate competitive), the devaluation expectation is uniquely determined and close to zero. Conversely, if the fundamental is extremely weak, $\phi < \phi_l$, the devaluation expectation is uniquely determined and close to μ. Finally, for middle values of the fundamental, $\phi \in]\phi_L, \phi_U[$, the parity is vulnerable to self-fulfilling expectations (i.e. it is "ripe for attack") as the devaluation probability may jump from a low level ($\pi_1(\phi)$) to higher values ($\pi_2(\phi)$ or $\pi_3(\phi)$) for a same level of the fundamental. This explication is known in the theory of non linear dynamics as a Bifurcation.

The question remains as to what determines the shift of the devaluation expectation from one level to the other. The answer is that anything could, in principle, trigger these shifts through so-called "sunspot" dynamics, whereby any arbitrary random variable or news becomes relevant as soon as the market believes it is relevant. Jeanne (1997) refers to "animal spirits"[12] and comments that "the model can accommodate different ways to specify the nature of animal spirits. These spirits may be determined by a publicly observable sunspot variable that co-ordinates the expectations of the foreign exchange market participants. [T]his sunspot variable does not need to be related to the fundamentals since it is sufficient for each individual to see that the others are speculating against the currency to join them, irrespective of the reason why they are doing so". [Jeanne (1997) p 273]. This view is akin to the theory of herding, as illustrated by Shiller (1995), in which market participants merely imitate others' actions, whatever their own beliefs[13].

It is interesting to recall here that economic theorists -mainly financial economists though- have searched for a theory that includes non-rational behaviour in speculative

[11] See Jeanne (1997) for proof of the proposition.
[12] Section 2.3.5. in this chapter shows how Jeanne & Masson (1998) later develop the idea of sunspots in the context of currency crises. Appendix A2 explains the concepts of sunspots and animal spirits.
[13] A model of herd behaviour can also be found in Banerjee (1992) and Lux (1995).

markets. The literature on informational cascades[14], for example, suggests that it may be optimal for a decision-maker to follow the actions (or signals) of all -or some- of those ahead of him. This may go as follows: suppose each investor gets information about the economy and decides publicly to sell or hold the currency. If the first n-1 investors receive a bad signal and sell, then the nth investor will choose to ignore his private information and sell, on the basis of the information drawn from what the others do. Lux (1995) shows how expectations can be made by imperfectly informed agents that fall in the process of mimetic contagion. Krugman (1998) furthermore argues that the possibility of self-fulfilling crises opens the way to market manipulation by large speculators[15]. The idea is that, once the currency is expected to be ripe for attack, a large speculator can take a short position in that currency to make profits, ultimately triggering the crisis. To illustrate Krugman refers to the case the pound sterling in 1992 when Soros' speculative moves arguably brought the exit of the pound forward.

The costs and benefits of defending a currency can be modelled in many ways in the second-generation framework and the fundamentals that matter can differ from one case to another. As a result, the second-generation literature is less homogenous than the Krugman-Flood-Garber strand and, truly, consists of a group of examples and special cases. The typical factors inducing the cost of a fixed, or managed, peg to become higher than the benefits are reviewed below.

2. 3. 1. Unemployment

In one archetype of the Second Generation literature, a government is tempted to devalue in order to create an "inflationary surprise" and reduce unemployment (or boost output). In the models presented below, high unemployment raises the cost of staying in the fixed rate system, which, in turn, raises devaluation expectations. Hence, it becomes even more desirable, if not inevitable, for the government to devalue the domestic currency. Additionally, the fixed exchange rate system is made unstable by any decrease in the opting out cost. This approach to currency crises is adopted by, inter alia, Chen & Giovannini (1994), Isard (1995), Drazen & Masson (1994), Masson (1995), Obstfeld (1991, 1994, 1996) and Jeanne (1997).

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[14] The cascade story is described in Banerjee (1992), Bickhchandani et al. (1992) and Shiller (1995).
[15] Krugman (1996) calls these large market manipulators "Soroi".

In Drazen & Masson (1994) and Masson (1995), currency crises are based on a Bayesian learning about the true type of the government and are only caused by fundamentals. The link between unemployment and the credibility of the peg is twofold. On the one hand, higher unemployment increases the temptation to abandon the peg and therefore is negatively related to credibility. On the other hand, growing unemployment improves the reputation of the monetary authorities as it signals that they do not devalue easily. The balance between the two effects depends on the parameters of the model and is an empirical issue. For France, Drazen & Masson (1994) find that the first -negative- relationship between unemployment and credibility dominated from 1987 to 1993. In the case of the UK, Masson (1995) estimates that there was an improvement in the monetary authorities' reputation although the first effect was more important.

In the infinite time stochastic models of Obstfeld (1991, 1994) the government minimises a loss function that is contingent on output and a fixed opting out cost [16]. Obstfeld's contributions show that multiple equilibria are possible inasmuch as two triggering levels of output shocks may exist. More recently, Obstfeld (1996) provides a prototype model that describes how high unemployment, in the context of a purely self-fulfilling mechanism, may cause an exchange rate crisis. A general prediction of the model is that the fundamentals determine the attack equilibria; but also, that there exists a wide range of values of the fundamentals that are not so strong as to make a successful attack impossible, nor so weak as to make it inevitable. Recall that in Krugman (1979), by contrast, if fundamentals are consistent with a fixed exchange rate; speculators will not co-ordinate on an attack equilibrium whilst an attack will occur if the fundamentals are inconsistent.

Jeanne (1997) models the benefit of the fixed exchange rate system given by equation (12), $B_t = b_t - \alpha\pi_{t-1}$, as a function of unemployment. The policymaker's loss function at time t becomes: $L_t = u_t^2 + \delta_t C_t$ where u_t is the deviation of the unemployment rate from its natural level, δ_t is a dummy variable equal to one if the policymaker abandons the fixed peg and zero otherwise and C_t is the opting-out cost. Assume that the

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[16] The details of Obstfeld (1994) are examined in Chapter 7.

unemployment rate is given by: $u_t = \rho u_{t-1} - a[e_t - E_{t-1}(e_t)]$[17], where u_{t-1} relates to persistence in unemployment. Assume also that the devaluation size is Δe, then if the policymaker decides to opt out, the unemployment will decrease as given by the following relationship: $u_t = u_t^d = \rho u_{t-1} - (1-\pi_{t-1})a\Delta e$. Conversely, if the devaluation does not take place, $u_t = u_t^f = u_t^d + a\Delta e$. In this context, the net benefit of the fixed peg is the difference between the loss of a devaluation and that of keeping the peg fixed, $B_t = L_t^d - L_t^f = C_t + (u_t^d)^2 - (u_t^f)^2 = C_t - 2\rho a\Delta e u_{t-1} + (a\Delta e)^2 - 2(a\Delta e)^2 \pi_{t-1}$ and can be rewritten as equation (12) if one sets the constant α equal to $2(a\Delta e)^2$, and the gross benefit of the fixed peg as a linear function of the unemployment rate and the opting-out cost, $b_t = C_t - 2\rho a\Delta e u_{t-1} + (a\Delta e)^2$.

2. 3. 2. Sunspots

On the basis of the reduced form of the second generation type of models, Jeanne & Masson (1998) show that the number of equilibria in a broad class of models can be infinitely large. As in Jeanne (1997), the basic idea of the model is that the net benefit of a fixed exchange rate system depends on economic fundamentals and devaluation expectations. The paper first describes a case where the equilibria are uniquely determined by the fundamentals, and then moves on to consider sunspot equilibria where devaluation expectations can be totally detached from the fundamentals[18].

The emergence of a continuum of equilibria lies in the timing of the devaluation expectations. Most models of currency crisis[19] assume that the net benefit of the fixed peg is a function of the previous period expectation of a future devaluation ($B(\phi_t, \pi_{t-1})$) so that $\pi_t = P[B(\phi_{t+1}, \pi_t) < 0 / \phi_t]$[20] and the number of possible equilibria is limited to three. In Jeanne & Masson (1998) and Krugman (1996), by contrast, the net benefit of a fixed exchange rate system depends upon the current period devaluation expectations

[17] The equation for the unemployment rate is consistent with the expectations augmented Phillips curve and the assumption of instantaneous purchasing power parity. See Chapter 7 for more explanation.
[18] A background to the concept of sunspots is given in Appendix 2.
[19] These include Jeanne (1997), Velasco (1996) and Obstfeld (1994, 1996).
[20] This is equation (14) of section 2.3. above.

and, therefore, $\pi_t = P[B(\phi_{t+1}, \pi_{t+1}) < 0 / \phi_t]$[21], which makes the number of equilibria much larger.

As showed above, in Jeanne (1997), the expectation of devaluation can jump from one level to another without any change in the fundamental under specific conditions. These jumps can be justified by the presence of a sunspot variable co-ordinating market expectations on one of the three possible equilibria. This brings Jeanne & Masson (1998) to formalise the concept of sunspots in currency crises. Assume that the economy can be in n states (s $1, 2, \ldots, n$) that correspond to n different levels of the fundamental triggering the expectation of devaluation(ϕ $\phi_1, \phi_2, \ldots, \phi_n$). If the state at time t is s, the government will abandon the peg if, and only if, $\phi_t < \phi_s^*$, where an asterisk denotes a critical threshold value of the fundamental[22]. Transitions between states correspond to changes in the government's decision rule following shifts in market expectations. They are assumed to follow a Markov process, with transition matrix $\Theta = [\theta(i,j)]_{1 \le i,j \le n}$, that is independent from the fundamentals, as well as from the government' preferences or type. Moreover, the ϕ^* solutions are, *a priori*, different from the critical thresholds of the fundamental-based equilibria (i.e. the ϕ_L and ϕ_U solutions in Jeanne (1997))[23].

It is shown in the paper that, in a sunspot equilibrium, the probability of opt-out depends jointly on the state variable and the fundamental variable, provided a condition is satisfied regarding the stochastic process followed by the fundamentals. More precisely, the devaluation expectation becomes the sum of the devaluation probabilities at time t weighted by the probabilities of transition from the current state to the next. As a result, the net benefit of the fixed peg is a joint function of the current state, s_t, the probabilities of transition to other states, $\theta(s, s')$, and the corresponding fundamentals threshold levels, ϕ_s^*. Jeanne & Masson (1998) explain that the states can be close together to the point where there exists a continuum of states.

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[21] Krugman (1996) attempts to question the second-generation approach by devising a model that leads to a unique equilibrium through a backward induction logic similar to that in Krugman (1979).
[22] The threshold levels of the fundamentals are ranked by increasing order so that ϕ_1^* ϕ_2^* ... ϕ_n^* and therefore, if the government opts out when the state is s, it will necessarily do so for any state of higher order.
[23] Yet the fundamental-based equilibria can be viewed as degenerate examples of the sunspot equilibria if the transition matrix Θ is an identity matrix.

Finally, Jeanne & Masson question the dynamics of devaluation expectations in second-generation models to demonstrate that devaluation expectations can be cyclical and chaotic and therefore lead to instability, when the benefit of a fixed peg depends on both current and previous expectations[24].

2. 3. 3. Interest Rates

Eichengreen & Wyploz (1993) and Obstfeld (1994) list different channels through which high interest rates become costly. For example, the prospect that a central bank may be forced to exercise its 'lender-of-last-resort' function may expose a government's foreign reserves to some strains, for it would need to extend its monetary base[25]. Also, changes in interest rates have income distribution consequences for borrowers and lenders. Third, high real interest rates may generate self-fulfilling devaluation pressures; fourth, international spillovers may result in contagious foreign exchange crises and finally, high interest rates increase the cost of servicing public debt. The three papers reviewed in this section -Obstfeld (1994), Ozkan & Sutherland (1998), Bensaid & Jeanne (1997)- have the common feature that they describe how a government optimally decides whether to stay in a fixed rate regime on the basis of the net cost of the peg in terms of interest rates.

In Obstfeld (1994), the cost of high nominal interest rates comes from the increased cost of servicing public debt. Two factors therefore play a central role: the maturity structure of the government's domestic obligations and the currency composition of the overall public debt. The basic assumption of the two-period model is that the government does whatever minimises its quadratic loss function, as given by the budgetary position inherited from the past. It may finance its second period budget deficit by taxing the economy or creating money, which implies a devaluation. The private sector has rational expectations about the government's objectives. The relative disadvantage of maintaining a fixed exchange rate rises with the domestic interest rate.

[24] Note that this is in contrast to the models maintaining that self-fulfilling elements solely augment the effects of deteriorating fundamentals, as in Obstfeld & Rogoff (1996), Cole & Kehoe (1996), Sachs & Radelet (1998) and Eichengreen & Wyplosz (1993).
[25] See Wyplosz (1993).

The model assumes that the government can borrow foreign exchange reserves indefinitely from the world capital market, subject only to the inter-temporal budget constraint. In the final analysis, as soon as the loss incurred in keeping the exchange rate fixed, as embodied in the interest rate, exceeds the costs of realignment the government's optimal decision is to devalue.

Two outcomes are therefore possible; either there are no devaluation expectations and the nominal interest rate is set at the foreign level, or the bond market expects the currency to be devalued, which then happens whatever the fixed cost of realignment. In other words, an equilibrium consistent with a fixed exchange rate parity can turn to multiple devaluation equilibria, because self-fulfilling realignment expectations make it too costly to keep the exchange rate fixed. With this model, Obstfeld (1994) clearly seeks to capture the idiosyncratic features of the September 1992 Italian crisis. Indeed, there is a lot of informal evidence that higher interest rates were no longer sustainable in Italy by the spring of 1992. "Italy is caught in a vicious circle whereby an increase in interest rates further undermines credibility because of the impact of an already excessive budget deficit" (Financial Times, September 5/6, 1992).

Ozkan & Sutherland (1998) also formulate explicitly the decision process of an optimising policy-maker concerned with internal balance[26] in an Escape Clause model where the private sector is cognisant of the optimising problem facing the policy-maker and thus builds expectations accordingly. It is assumed that the system is dominated by a centre country (Germany) that sets its interest rate so as to achieve its own monetary objectives so that, from the domestic viewpoint, the foreign (German) interest rate is exogenous and subject to stochastic shocks. In other words, the domestic nominal interest rate is merely set so as to maintain the fixed exchange rate. As a result, the foreign nominal interest rate plays the central role in the model and the cost of high interest rates translates directly into an output loss and -given that the welfare of the government is a function of domestic output- into lower welfare for the policy-maker. In equilibrium, the 'trigger point' (i.e. the level of the foreign interest rate at which the government decides to quit the fixed regime) must satisfy the condition that the private sector's expectations of the government's trigger point are correct.

In this context, a fully optimal outcome can only be reached if a credible pre-commitment is possible. That is, if a restraining announcement about a very high exit trigger level for the foreign interest rate can truly prompt a positive effect on the differential between the domestic and foreign interest rates. Failing this, the exit from the fixed regime will occur at an earlier date than was intended, hence the possibility of an ex-ante sub-optimal equilibrium trigger point. Ozkan & Sutherland (1998) recognise that the optimal trigger point is irrelevant in the ERM context, for the real world system does not contain any mechanism for a government to credibly pre-commit. Obviously, no EMS countries' government ever announced exit trigger levels for any variable. However, most indeed regularly proclaimed that their currency would never be withdrawn from the ERM. In this respect, we are left with the state-consistent trigger point; i.e. "[..] the point at which the government has an incentive to implement the regime switch given that the private sector believes that it will be implemented at that point". It then becomes optimal for the policy-maker to violate its promise immediately, i.e. at a sub-optimal point.

Likewise, in Bensaid & Jeanne (1997) high foreign interest rates generate devaluation expectations that, through uncovered interest rate parity, determine the domestic interest rates. The model differs from Obstfeld (1994) and Ozkan & Sutherland (1998) in that it introduces informational asymmetry between the government and the public. In summary, speculators know that it is costly for the government to resist speculation by raising interest rates but they do not know when the peg will be abandoned because they are uncertain about the value of the government loss in case of an opt-out. Therefore they keep up the pressure, thereby pushing domestic interest rates even higher so that, eventually, the interaction between the monetary authorities and the public falls into a vicious circle.

The model implies that a realignment is the inevitable outcome of any speculative attack and that, in this respect, the decision variable is the opting out date[27]. The regime switch is modelled as a sunspot; i.e. a force that operates outside the theoretical model to

[26] That is, a government that wants to loosen monetary policy and boost aggregate demand.
[27] It is notable that, by contrast with Obstfeld (1994), Bensaid & Jeanne (1997) do not assume that the government is expected to follow an expansionary policy after the exit.

trigger a self-fulfilling attack. Hence, if this triggering shock fails to occur, the domestic interest rate is always equal to the foreign interest rate. But as soon as a shock takes place, the domestic interest rate enters a danger zone and follows the dynamics of a currency crisis. As the authors phrase it, conclusions drawn from this model are rather pessimistic since any government is vulnerable to speculative attacks at any time, speculative attacks always result in a devaluation and a good reputation does not actually prove to be an advantage. Finally, there are two ways the government can get out of the crisis: one is to devalue, the other is to wait for the arrival of good news, in which case speculators may stop putting pressure on the currency.

2. 3. 4. Public Debt: Level and Maturity

Giavazzi and Pagano (1990) stress that shorter debt maturity implies increasing borrowing needs in the near future. As these needs should be faced by either rolling over the existing debt at increasing interest rates (thus inducing higher tax burdens in the future) or by expanding the central bank domestic credit, they jeopardise the maintenance of the existing exchange rate parity. Hence, macroeconomic fundamentals may be consistent with the exchange rate policy but the interaction between the private sector's expectations and the government's objective function may lead to self-fulfilling expectations that increase the cost of rolling over public debt and force the government to resort to financing from the central bank. As detailed above, in Obstfeld (1994), the higher the level of debt, the higher the cost in terms of interest payments when the domestic currency is attacked, because of the increase in domestic interest rates. In this setting, it becomes more likely that the government will prefer to renege on the existing exchange rate peg and relax monetary policy in order to avoid further increases in debt and higher costs of financing.

Velasco (1996) investigates the importance of the level of public debt for foreign exchange markets. The idea is that multiple equilibria and self-fulfilling currency crises are possible for certain levels of debt. The higher the gross government debt level and the devaluation expectations, the greater the temptation to opt out of the peg. Besides Velasco (1996) shows that, as in Drazen & Masson (1994), the level of the state variable (debt in Velasco and unemployment in D&M) can have two opposite effects. If the government chooses to devalue -and therefore reduce the debt level- expectations of future devaluation may either rise or decrease. The government's reputation may worsen as the devaluation is a signal of softness, but it may also improve as the reduction in debt alleviates the temptation to devalue again. Cole & Kehoe (1996)[28] establish the existence of a recursive equilibrium in which consumers and bankers estimate the probability that the government will default on the basis of the current debt stock, the new debt issue, the current capital stock, and the realisation of a sunspot variable. Given the guessed probabilities of default, the model determines the actions of the consumers and bankers and, given these actions, the government's optimal behaviour can be derived. As in typical second generation models, there is a tripartite division of the state variable (the debt stock). That is, for a low enough debt level, the government will not default, whatever the realisation of the sunspot variable. For an extremely large debt stock, default will occur immediately (even if the issue of new debt is small). Finally, there exists a middle zone of the debt values for which a crisis may take place, depending on the realisation of the sunspot variable. Moreover, the size of this danger zone depends on the maturity of the government debt (with debt of long maturity, little borrowing is necessary in any one period and the government may be able to honour his commitment).

2. 3. 5. Information

The main drawback of the second-generation story is that is fails to explain the co-ordination mechanism that leads all market participants to attack a currency at the same time. The models presented above require that speculators have common knowledge of the fundamentals and then explain the onset of an attack as an *ad-hoc* shift in market expectations, so that the economy moves from the no-attack to the attack equilibrium. Morris & Shin (1998) demonstrate that the absence of public and transparent information can remove the multiplicity of equilibria in second-generation models. The paper presents a speculative game in which information is not public and transparent in the sense that, even if market speculators receive correct positive signals of the state of the fundamental, they do not know how informed others are and therefore can only

[28] Cole & Kehoe (1996) have the experience of Mexico in mind.

guess others' beliefs. Consequently, each individual market player must think about the full range of beliefs held by others and study possible actions in case the parity becomes unsustainable. If there is a high probability that others believe that the currency is extremely vulnerable and if the transaction cost is not too high, then each investor will find it rational to speculate, although the peg is otherwise viable. Vice versa, if it is highly probable that others see the currency as sustainable and if it is costly to take a position against the currency, then each investor will decide to hold onto the currency. In the final analysis, there is a critical value below which an attack always occurs and above which an attack never happens, and that critical value depends on the mass of speculators, speculation costs and the state of the economy.

2.3.6. Banking System: Twin Crises

In an informative contribution, Corbett & Vines (1998) claim that the Asian financial crises were due to the vulnerability created by inadequate macroeconomic policies (i.e. contractionary fiscal policy and inflexible monetary policy due to the fixed peg), alongside an inadequate financial system development (i.e. the liberalisation of trade and finance in a yet-to-be-reformed financial system). Looking at Thailand's case, the paper also argues that a financial collapse can be the consequence of a currency crisis. The idea is that a devaluation increases the value of unhedged foreign currency liabilities so that lenders come to believe that the government will not be able to honour its loans, panic sets in, and the collapse ensues. In turn, the financial crisis triggers an even more severe currency crisis and the system thereby falls into a vicious circle.

In Calvo (1996b), Calvo & Mendoza (1996) and Irwin & Vines (1999) a precarious financial position of the banking system can make a sudden currency crisis more likely. If a currency crisis goes through a bank run -that is, if the domestic money that is exchanged for international reserves is withdrawn from the banking system- expectations that the central bank will increase domestic credit creation to support commercial banks produce the conditions for a self-fulfilling currency crisis. In such a case, the abandonment of monetary discipline takes place because the central bank tries to avoid the credit squeeze and the bankruptcies that would occur if domestic credit to the banking system were not expanded.

2.4. Contagious Crises

Typical illustrations of contagion in Europe are given by the speculative attacks on the Nordic currencies, on the Irish pound when sterling was floated in September 1992, and on the Portuguese peso when the Spanish peseta was devalued in 1993. In the Nordic case, in particular, a wave of speculation triggered by the floating of the Finnish markka on 8th September was followed by the abandonment of the Swedish krona's ECU parity on 18th November. In turn, the Swedish crisis put pressure on the Norwegian krone so that Norway, in the end, also suspended her link to the ECU on 10th December.

Although it does not strictly fall within the first generation strand, Gerlach and Smets' (1995) contagious crisis model is based on the balance-of-payments framework. In light of the events that occurred in Denmark, Norway and Sweden in the fall of 1992, Gerlach & Smets take the view that contagion takes place when a speculative attack on one currency provokes an attack against the currency of a trading partner. Their two-country version of the Flood-Garber Speculative Attack model shows that, in the presence of nominal rigidities, a devaluation gives a country a temporary boost in competitiveness. That country's trade partners are then at a competitive disadvantage and some may see their currency come under attack. In this context, an infectious contagion of exchange rate crises may occur amongst trade competitors even when their currency pegs are otherwise viable. When the public observes that the competitiveness of a neighbouring country is threatened, they revise their expectations of the evolution of its economic variables and attack its currency. The model further shows that contagion is more likely the more integrated trade is between the two countries, the lower the degree of real and nominal wage flexibility, and the less integrated the two countries are with the centre country.

Masson (1998) also develops a simple two-country balance of payments model that allows for the phenomena of contagion and multiple equilibria. It is important to note however that Masson makes a clear distinction between three types of contagion; namely, pure contagion, monsoonal effects and spillover effects. Pure contagion corresponds to self-fulfilling shifts in market expectations totally detached from observable economic considerations. Monsoonal effects are the result of a common external cause having similar consequences on different currencies (e.g. a weak US dollar in the early 1990s arguably led to pressure against the ERM currencies by contributing to the strength of the German mark[29]). Spillovers are –as in Gerlach & Smets (1995)- the outcome of the trade linkages between countries. Masson's model demonstrates how the three contagion effects operate and how pure contagion gives rise to jumps between equilibria.

2. 5. First vs. Second Generation Debate

The only serious criticism of the second-generation theory of currency crisis is Krugman (1996). Although Krugman (1996) admits that the modelling of a government's objectives in the new models is an improvement on the old literature (based on the assumption that excessive credit creation will deplete reserves), his doubts concern the self-fulfilling component of the theory[30]. Krugman's main argument is that the new generation of models can lead to a unique equilibrium, if one reintroduces the assumption of a predictable deterioration in the fundamentals as in Krugman's (1979) original contribution. Krugman (1996) uses a process of backward induction to show that a devaluation will take place as soon as the deteriorating trend in the fundamentals make it possible to expect one, thereby reducing the possibility of multiple equilibria[31]. Moreover, Krugman attempts to illustrate his assertion by examining the 1992/93 ERM crises and arguing that the transitory deterioration in the fundamentals[32] of the countries hit by the speculative attacks rejects the hypothesis of self-fulfilling crises.

However, in his response to Krugman's discussion, Obstfeld[33] points out that Krugman has incorrectly dissociated the economic and purely self-fulfilling components of the new theory. Obstfeld therefore reminds us that what new models suggest is that, for

[29] It has also been suggested that the German re-unification caused pressure in the ERM although the European crises took place well after the re-unification

[30] Krugman (1998) clearly admits that his 1979 paper and subsequent first generation models represent government policy in too mechanical a way.

[31] Krugman (1996) furthermore extend the model to the case where the public does not know the government's objective function, and to the possibility of stochastic deterioration in fundamentals.

[32] Krugman (1996) examines the real exchange rate, unemployment rate, output gap, inflation rate and debt/GDP ratio of France, Italy, the UK, Sweden and Spain.

[33] In the same publication.

some range of the fundamentals, self-fulfilling expectations and multiple equilibria can arise, whilst what they do not say is that currency crises are completely detached from the fundamentals. Additionally, Obstfeld is skeptical of both the model and empirical evidence Krugman uses to distinguish between crises that are fundamental-justified and self-fulfilling ones. Finally, Obstfeld concludes that Krugman' discussion does all but reject the case for the new models. It is interesting to note here that Krugman later gives in and changes his position. Krugman (1998), indeed, justifies the application of second generation models. He even writes "Part of what makes the ERM crises so classic is that they so clearly demonstrate the importance of second, as opposed to first, generation models. " [Krugman (1998) p16]

Part 2: Empirical Evidence

Different methodologies, countries and time periods, as well as diverse definitions of currency crises make it difficult to compare results across the existing empirical literature. This section therefore only attempts to provide an up-to-date synthesis of the most significant studies of currency crises.

2. 6. Tentative Qualitative Explanations

2. 6. 1. Removal of Capital Controls

Following the June 1988 decision to lift the capital controls within the EMS, it was commonly believed that free trade, full capital mobility, fixed exchange rates, and independent monetary policies made up an 'inconsistent quartet' of policy objectives that, ultimately, would build up to a crisis. Recall, for example, Wyplosz (1989): " The removal of capital controls by mid-1990 will subject EMS currencies to such instability that systematic realignments will no longer be possible under present ERM arrangements. The only way to achieve stability in the EMS after mid-1990 is to eliminate inflation differentials among members -complete monetary harmonisation".[34]

Capital controls allow a country to maintain some degree of monetary policy independence, in spite of the commitment to fixed peg, by limiting fluctuations in domestic interest rates due to changes in world rates and devaluation expectations. In the ERM, capital controls effectively restrained speculative pressure (particularly in France and Italy) as they restricted the flow of asset transfers. Giavazzi & Giovannini (1989) argue that capital controls in the ERM helped to avoid or withhold realignment in crisis periods (mostly during episodes of dollar weakness). European financial market liberalisation gave rise to substantial cross-border capital flows into higher yielding ERM currencies (for example, there were massive capital inflows to Italy and Spain during a few years before the 1992 crisis). Yet, the increase in nominal exchange rate volatility did not materialise immediately after most ERM countries had abolished capital controls in the early 1990s. Capital outflows intensified only in the summer of 1992, when international investors started to bet extensively against some of the parities. In this sense, high capital mobility may have led to the 1992-1993 situations where the authorities became overwhelmed as they attempted to avoid speculative attacks.

2. 6. 2. Lack of Convergence

Isard (1995) argues that the 1992-93 crisis was an attack precipitated by the inconsistency between the degree of official commitment to avoiding exchange rate adjustment during the transition to a common currency and, the level of progress in achieving macroeconomic convergence. Along similar lines, Crockett (1994) lists the conditions that encouraged the disturbances of 1992-93 crises: (i) free capital mobility, (ii) structural rigidities impeding the timely adjustment of domestic costs and prices, and (iii) the fact that policy instruments have a different impact in different countries. In particular, short-term interest rates were of much more importance in Ireland and the UK for housing finance, and in Italy for the fiscal position (because of the very high

[34] For other contributions on the implications of capital liberalisation in the ERM, see Artis & Taylor (1988)

level, and short maturity, of government debt) than in Germany, where long term interest rates and monetary aggregate M3 were targeted. Otherwise mentioned discrepancies relate to unemployment, interest rates, and fiscal positions (in the case of Italy); and the policy conflicts arising from the cyclical position of the EMS member countries (notably in the UK).

Furthermore, it is widely argued that the German reunification created some disequilibrium in the EMS[35]. Buiter et al. (1998) argue that Germany's reunification process was "turned into a textbook example of macroeconomic mismanagement, eventually resulting in the adoption of a monetary and fiscal policy mix that was undesirable even for Germany, let alone for the EC as a whole"[36]. As a result of the German reunification in 1990, German monetary policy was only loosened moderately and interest rates grew higher, at a particular time when public spending was increasing sharply, the current account surplus had turned into a deficit and inflation was on the rise. Subsequently, despite the tightness of the German policy and the prospect of an oppressive European economic recession, ERM member states persevered to peg their respective currencies tightly to the mark, thereby denying the evidence and undermining the credibility of their currencies.

2. 6. 3. Wrong Fundamentals

Suggestions as to a possible role played by 'fundamental variables' range from the discrepancies in unemployment, interest rates, and fiscal positions (in the particular case of Italy), to some policy conflicts arising as a result of the recession (and notably the cyclical position of the UK). It is true that all the countries that were hit during the first wave of speculation had either cumulated large current account deficits, or had undergone a considerable real exchange rate appreciation since the last realignment, or both. However, at the time speculators attacked the French and Belgian Francs and the Danish Krone, none of these exchange rates was unsustainable in the sense that the

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and Eichengreen & Wyplosz (1993).

[35] See, for example, Buiter et al. (1998), Krugman (1998), Gros & Thygesen (1998)

[36] The fact that the crisis did not immediately follow the shock of Germany's reunification may be due to an overdue reaction of speculators who anticipated that Germany would handle the reunification better than it did.

classical crisis models postulate[37]. Krugman (1998) stresses that ERM countries were under pressure to lead expansionary monetary policies because of the high levels of unemployment (due to inadequate demand), but that such policies were not feasible under the ERM arrangement. The role of fundamentals in currency crises is a major aspect of the empirical literature and is discussed more extensively below.

2. 6. 4. Non-Rational Behaviour of the Market

Eichengreen & Wyplosz (1993) report answers to questionnaires mailed to European traders[38] and generally rule out the pertinence of the then fundamentals in explaining the 1992 attacks. Indeed, they find that market sentiments mainly support the self-fulfilling expectations interpretation of the 1992 crisis since less than twenty two percent of respondents had expected a realignment before the Danish referendum. Moreover, a review of the information available during the first eight months of 1993, as presented by Kregel (1994), gives some weight to the argument that irrational market expectations can cause damaging speculation and result in the collapse of fixed exchange rate arrangements. Kregel effectively argues that, unlike the September 1992 events, which "were mainly due to legitimate actions by global portfolio managers to cover international investments", the attacks on the French Franc in the summer of 1993 are a typical illustration of excessive pressure against a currency.

2. 6. 5. EMU

Among the assumptions mentioned regarding the ERM crises, one is the uncertainty about Maastricht or, perhaps more importantly, the EMU process. Indeed, the strong view was raised by various observers that the EMS suffered from the 'destabilising' effect of EMU. The most common argument goes that the project of EMU, together with current account imbalances, made participants in foreign exchange markets focus on the need to adjust the parities. The second argument[39] relates to the issue of international banks assimilating EMU to the loss of an essential source of income -i.e. the foreign exchange market- and seeking to prove that changes in parities were

[37] The models referred to are Krugman (1979) and Flood & Garber (1984a).
[38] That is, all European traders listed in the *Currency and Instruments Directory*, Citibank (1990).
[39] See Giovannini (1994).

necessary and large capital movements were an equilibrium outcome. Accordingly, speculators were looking for the optimal timing of the change in the perceived unsustainable exchange rate parities, so that the difficulties in the ratification process (the Danish referendum and/or the run-up to the French one) sufficed to speed up the speculative attacks.

Subsequently, several theories of the EMS currency crises ascribe a role to the publication of deadlines for EMU and to the convergence criteria. The contention is that fixed dates made backward induction an easy exercise; inasmuch as investors could determine which economies were unlikely to meet the convergence criteria by the specified deadlines. Therefore, much emphasis has been put on the idea that it is the gradualism in the EMU reform which is to blame, because the little credibility of gradual reforms invites speculation about their future success and makes them vulnerable to self-fulfilling speculation.

2. 6. 6. Co-ordination Failure

Anecdotal evidence of the absence of cohesion among the ERM member states is awesome and has widely been exploited by the press and the academic world[40]. After the German reunification in 1990, Germany clearly refused to give up its monetary policy stance so that an appreciation of the mark became almost inevitable. ERM member states nonetheless opposed a general realignment, disregarding the claims of the Bundesbank. Furthermore, many also argue that the strengthening of the mark relative to the dollar created tension in the ERM as the divergent monetary policy stance implemented by the USA and Germany made the EMS agreement flawed and asymmetric by worsening the cohesion problem between the European policies[41].

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[40] Buiter et al. (1998) provide a theoretical framework to interpret the co-ordination failure of the ERM member country in a centre-periphery model.

[41] Giavazzi & Giovannini (1989) provide an empirical assessment of the importance of the DEM/$ exchange rate for the EMS.

2. 7. Quantitative Methodologies

2. 7. 1. Devaluation Expectations and Economic Fundamentals in the ERM

Rose & Svensson (1994, 1995) investigate the potential determinants of realignment expectations[42]. More precisely, they test whether (permanent) changes in the macroeconomic variables are associated with (permanent) changes in the level of realignment expectations by use of a Vector-Auto-Regressive model. The authors consider a whole set of macroeconomic variables: namely, money, output, inflation, the level of international reserves, trade balance, the real exchange rate, and also the amount of monetary independence (as measured by the standard deviation of expected future exchange rate drift within the band)[43]. Estimates reveal that the credibility of the ERM varies significantly over time, mostly for reasons that cannot be explained by standard macroeconomic variables[44].

Chen & Giovannini (1994) examine the causal relationship between realignment expectations and the information variables rather than their correlation. The paper provides estimates of realignment expectations calculated by use of the drift-adjustment method for the FRF/DEM and ITL/DEM exchange rates during the period March 1979 to January 1992. The estimation is based on the 'projection equation' methodology that assumes rational expectations and a linear structure, and projects realignment expectations on available information sets (economic fundamentals, central bank reputation and institutional arrangements of the EMS). Regression results show that fundamentals are only very weakly significant in explaining expectations of realignment[45]. The most important variables -i.e. those with the highest explanatory power- turn out to be the length of time since the last realignment and the deviation of

[42] See Chapter Six for description of drift-adjusted realignment expectations.

[43] Tabellini (1994) points out that Rose & Svensson omit a potentially important determinant of credibility: fiscal policy, and that they miss to include in their estimation measures of 'institutional' differences -"a central determinant of credibility".

[44] Note that Rose and Svensson find that movements of realignment expectations appear to be common to ERM participants, suggesting that the credibility may be shared by all members of the system.

[45] More precisely, the results suggest that there exists a negative relation between the realignment expectations and the relative strength of the domestic and foreign macroeconomic fundamentals but they are not statistically significant.

the exchange rate from the central parity. That is, refraining from realignment generally ameliorates the government's reputation in the short-run. The paper corroborates the general observation that the deviation of the exchange rate from the central parity is positively correlated with devaluation expectations[46].

2. 7. 2. Stylised Facts Pre- and Post-Crises

Eichengreen, Rose and Wyplosz (1995) (henceforth ERW) search for a set of politico-economic fundamentals, sensibly and consistently linked to speculative attacks[47]. The analysis is therefore designed as an examination of the causes and consequences of the speculative pressure affecting both pegged and floating rates, in a more or less simple event study, gathering facts on the entire post-war experience of 20 OECD countries, but not testing any particular theory of speculative attacks. Speculative pressure is measured as a weighted average of exchange rate changes, interest rate changes and the negative of reserves changes, where all the variables are relative to Germany's. Speculative attacks are thus defined as periods when the index, thereby constructed, hits extreme values (i.e. at least two standard deviations above the mean).

Searching for regularities in various periods of speculative pressure, ERW cannot draw any distinct conclusion about what makes attacks succeed or fail, for the macroeconomic variables were mostly alike between such periods. Nonetheless, the conclusion is reached that the data do not refute models of self-fulfilling speculative crises, on the grounds that many crises are not preceded nor followed by weak policies, that many crises are not linked to the characteristic variables put forward in the classical model, (e.g. M1 and M2 growth is not high prior to devaluations while reserves continuously fall) and most crises were not expected by the market.

There are objections that these events are evidence of self-fulfilling crises. Weber (1995) argues that ERW's statement is strong in view of such informal evidence,

[46] Note that a general prediction of target zone models, by contrast, is that exchange rates tend to return to the centre of the band, as a result of a 'stabilisation' effect.

[47] Frankel & Rose (1996), Kaminsky & Reinhart (1996), Milesi-Ferretti & Razin (1998) also use event studies in addition to other approaches.

recalling that money is endogenous and represents a feature of business cycles, which may simply be what the study identified. Krugman (1996) explains that, firstly, evidence that crises do not follow the patterns described in traditional models does not provide evidence of self-fulfilling crises; secondly changes in policies are features of self-fulfilling models[48] and not of the traditional models; and finally, according to the escape clause models, markets should anticipate the crises even when they are self-fulfilling[49].

2. 7. 3. Discrete Choice Analysis

The discrete choice analysis treats the discrete binary variable (i.e. crisis and no crisis) as the realisation of some probability distribution. More precisely, let Y_{it} denote the regressand for country i in period t that takes a value of one if a crisis occurs and zero otherwise; let X_{it-1} be a vector of explanatory variables (or indicators) and β be a vector of parameters, then the probability of a crisis is: $P(Y_{it}\quad 1)\qquad f(\beta' X_{it-1})$ where $f(.)$ is a probability distribution function. $f(.)$ can be the logistic distribution in a so-called logit model or the normal distribution in probit models[50]. The parameter vector β is estimated by maximum likelihood. Additionally, researchers usually pool the data across country and time to form a large panel data set that includes "enough" crisis observations. Pooling the data however implies that one makes the assumption that crises are alike across countries which has raised doubts among economists. Typical examples of the use of this methodology include Frankel & Rose (1996), Funke (1996), Glick & Rose (1998) and Kumar et al. (1998) for currency crises, and Demirguc & Detragiache (1998) for banking crises.

For example, Frankel & Rose (1996) (FR) examine a range of potential causes for currency crashes in 105 developing countries over the period 1971 to 1992. A currency crash is simply defined as a nominal depreciation rate larger than twenty five percent

[48] Most self-fulfilling models -except for Bensaid & Jeanne (1997)- suggest that attacks should be followed by a shift to more expansionary monetary and fiscal policies.
[49] Other aspects in models with self-fulfilling expectations suggest that speculators may not have been totally rational.
[50] The choice between the two distributions is discretionary since they are similar. However, one can argue that the logistic distribution has a closed form and thicker tails, whilst the use of the normal distribution is justified by the law of large numbers.

that also exceeds the previous year's change by ten percent. The univariate graphical analysis is analogous to Eichengreen et al. (1995) and the multivariate statistical analysis is a probit model based on annual data. The graphs suggest that most variables (debt-composition variables, reserves, current account, real exchange rate divergence, government budget, domestic credit growth, real output growth per capita, foreign interest rate and the real output growth rate in developed countries) move slowly before currency crises. The regression results show that crashes are more likely in circumstances where there is a recession, when domestic credit growth is high, reserves are low, interest rates in developed countries are high, the real exchange rate is overvalued and when capital inflows fade. It is found however that neither the current account nor the government budget deficit influences the occurrence of typical crashes.

Demirguc & Detragiache (1998) concentrate on banking crises. A crisis is said to have occurred either when banks are nationalised on a large scale after the crisis; or when the ratio of non-performing assets to total assets exceeds ten percent; or when bank runs took place and emergency measures were taken by the government after the crisis (e.g. deposit freezes, generalised deposit guarantees, or prolonged bank holidays); or finally when the rescue operation cost more than two percent of GDP. Macroeconomic, financial and institutional variables are used in a logit model that suggests that banking crises are the result of weak economy that is vulnerable to output shocks. It is also found that the probability of a banking crisis is not sensitive to currency fluctuation and that there exists a moral hazard problem arising from the presence of explicit deposit insurance.

Okter & Pazarbasioglu (1997) identify episodes of speculative pressure for six ERM currencies (i.e. BEF, DKK, FRF, IRP, ITL and ESP). They use a probit model to calculate the one-month ahead probabilities of regime change as a function of interest rate differentials, changes in reserves and deviations of the exchange rate from its central parity. In a second step, the set of probabilities is then used to estimate the contribution of macroeconomic fundamentals, as suggested by a monetary model of exchange rate determination[51]. The study leads to the general conclusion that "[...] consistent macro policies are necessary but not sufficient to ensure the maintenance of an exchange rate peg." Furthermore, the comparison of the results over two different periods (i.e. 1979-1995 and 1979-1993) suggests that the widening of the ERM fluctuation band did not result in less speculation.

Various other papers adopt a similar approach. Ozkan (1996) tests optimising models of currency crisis with respect to the experience of the ERM. A currency crisis is defined as an actual -rather than expected- realignment. The regression equation is therefore: $P(z_{it}-1)\ \ F(\alpha_i\ +\beta\ x_{it})$ where $i\ \ 1,..,N$ and $t-1,\ldots,T$ and $P(z_{it}\ \ 1)$ is the probability of realignment for country i at time t, x_{it} is the vector of explanatory macroeconomic variables and α_i measures country specific unobserved effects, assumed to be constant over time. Estimation is based on pooled monthly data from 1979 to 1992 for Belgium, Denmark, France, Italy, Holland, the UK, Portugal and Spain. Results of the logit model show that realignments are influenced by movements in output, unemployment, competitiveness, foreign exchange reserves and the country specific variable, in at least up to three months. The investigation of Funke (1996) resembles Ozkan (1996) although the former uses a composite explanatory variable (i.e. a weighted average of significant fundamental variables), a probit model and quarterly data from 1979 to 1995[52]. Like Ozkan, Funke finds that currency realignments and crises can satisfactorily be explained by the fundamentals. Goldfjan & Valdes (1998) estimate one-month-ahead probabilities of currency crises as a function of real exchange rate misalignment and expected devaluation using a logit model. A currency crisis is measured first as a large nominal devaluation rate, second as a large change in the real exchange rate and third, Goldfjan & Valdes use the list built by Kaminsky & Reinhart (1996). The study is based on panel data for 26 countries from 1984 to 1997. Overvaluation is found to be relevant in explaining currency crises but the measure of expected devaluation is not. The use of both variables together does not provide significant results and therefore the study is not very conclusive. Milesi-Ferretti & Razin (1998) examine the potential determinants of current account deficits and

[51] The explanatory variables therefore include the central parity, domestic credit, real output, the short-term interest rate and price level in the centre country and the real exchange rate.
[52] Funke also differs from Ozkan (1996) as the data sample includes four more countries: Ireland, Norway, Sweden and Mexico.

currency crises in low- and middle-income countries. Estimation of the probit model leads to the conclusion that both exchange rate crashes and reductions in current account deficits are related to domestic factors and external ones. Currency crises in particular occur when reserves are low; the real exchange rate has appreciated; terms of trade are unfavourable; interest rates are high and when growth in industrial countries is slow. Kumar et al. (1998) also follow the same methodology (a logit model), looking at various Eastern European, Asian, African, Middle East and Latin American countries. Two important features of the study are the use of monthly data (obtained by interpolation of annual data) and the large set of explanatory variables, including a liquidity indicator, risk appetite and commodity prices. It is found that currency crashes -defined as large devaluations, corrected for interest rate differentials - can be explained by reserves, exports, real GDP, contagion and capital flows.

Esquivel & Larraín (1998) apply a probit model to a panel data set of thirty diverse countries between 1975 and 1996. The paper focuses on successful currency crises, i.e. on abrupt changes in nominal exchange rates[53]. The model is a probit model with random effects. The method is argued to be the most efficient at modelling dependent binary variables and repeated observations of the same group of countries over time. Furthermore, it takes country-specific characteristics into account. Assume there is an unobservable variable y_{it}* described as: $y_{it}^{*} = \beta' X_{it-1} + u_{it}$ where X_{it-1} is a vector of explanatory variables for country i in period $t-1$, β is a vector of coefficients to be estimated and u_{it} is a composite error term defined as: u_{it} $\alpha_i + v_{it}$; where α_i is a random -country specific- effect and v_{it} is an i.i.d. error term. It is then assumed that the observed currency crisis variable behaves as follows: $y_{it} = 1$ if $y_{it}^{*} > 0$; and $y_{it} = 0$ otherwise. A probit model with random effects is thus specified as: *Prob(crisis)* *Prob*(y_{it} *1*) $\Phi(X_{it-1})$ where Φ represents the standard normal distribution. Results show that currency crises are not alike but there exist common features across crisis episodes. The most significant determinants of currency crises include negative shocks to terms-of-trade, low foreign exchange reserves relative to a broad measure of money, current account deficits, negative per capita income growth, high rates of seignorage, a contagion effect,

[53] More specifically, a currency crisis is defined as a nominal devaluation that is large compared to the average for the currency and meaningful, i.e. it affects the real exchange rate at least in the short run.

and real exchange rate misalignment. On this basis, the authors argue that second generation theories complement rather than substitute first generation models.

Glick & Rose (1998) look at crises in several cross-sections of countries in years of widespread currency crises to test the importance of trade linkages and macroeconomic features as channels of contagion in currency crashes. The empirical paper is based on the estimation of the following binary probit equation: $Crisis_i \quad \varphi\, Trade_i + \lambda M_i + \varepsilon_i$, where $Crisis_i$ is an indicator variable equal to one if country i is attacked in a given period and zero otherwise[54]; M_i is a set of macroeconomic regressors; λ is the corresponding vector of coefficients to be estimated (via maximum likelihood); and ε is a normally distributed disturbance. The crucial null hypothesis is that $\varphi=0$ so that rejection of the null is assumed to be evidence of a trade contagion effect. $Trade_i$ is measured as a weighted average of the importance of trade between the first victim of each crisis and country i. The macroeconomic variables include domestic credit growth, government budget, current account, real GDP growth, the ratio of M2 to reserves and the degree of currency under-valuation. Data are annual and include 161 countries (from Europe, Africa, Asia, and the Americas). The paper focuses on five episodes of speculative attacks: the Breakdown of the Bretton Woods system (1971), the collapse of the Smithsonian Agreement (1973), the EMS crisis (1992-93), the Mexican crisis and Tequila Effect (1994-95) and the Asian Flu (1997-98). Univariate and multivariate regressions strongly suggest that, although it varies across episodes, trade is a significant and consistent channel for contagion, whilst macroeconomic variables do not explain the occurrence of regional currency crises[55]. Note that the methodology does not help to predict crises unless one knows which country initiates the contagion.

2. 7. 4. Non-Parametric Signalling Methodology

The signalling approach draws upon the business cycle literature, and is an extension of the methodology that compares the behaviour of variables preceding crises with that in

[54] The binary series is constructed on the basis of journalistic and academic accounts of crisis episodes.

a control group[56]. Deviations of some variables from their normal levels beyond a threshold value, are taken as warning signals of a currency crisis within a specified period of time. A critical phase in the application of this methodology is therefore the definition of the threshold. Usually, the selection is based on the balance between type I and type II errors, i.e. between failing to signal a crisis when it actually takes place and predicting a crisis that does not happen. The most common approach is to estimate the probability of a currency crisis in future periods in multivariate logit or probit models. Selected variables summarise the information about the likelihood of a crisis[57] and provide the warning signals. Pooling data across country and time is also typical of signalling approach on grounds of asymptotic validity. Kaminsky & Reinhart (1996), and Kaminsky, Lizondo & Reinhart (1998) (KLR) are representative investigation based on the signalling approach[58].

KLR propose an early warning signal approach based on a large set of monthly indicators for 76 currency crises in 20 countries[59] from 1970 to 1995. The idea is that when an indicator exceeds a certain threshold value it provides a warning signal that a crisis will occur in the next two years. A crisis is identified as a large depreciation of the currency or a sharp loss of international reserves or a combination of both[60]. The best performing indicators (i.e. those that do not provide false signals and do not miss many crises) identified on this basis include exports, equity prices, real exchange rate misalignment, output and the ratio of broad money to gross international reserves. Additionally, KLR provide a thorough survey of the empirical literature on leading indicators of currency crises. The paper compiles a list of the indicators of crises in various countries. Overall, results across the whole panoply of studies do not provide a clear cut answer as to how the potential indicators may be used to forecast crises[61].

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[55] Note that Glick & Rose test for the robustness of their results by using two other regressands: the cumulative percent change in the devaluation rate and an index of exchange market pressure (see Chapter Five for details on the index).

[56] To find out the effect of a particular variable on the probability of a crisis, the changes in probability are compared when that explanatory variable takes different values and the other variables are maintained at their mean value.

[57] Again, a currency crisis is defined differently depending on the paper.

[58] One may also mention Berg & Patillo (1998) who re-estimate KLR.

[59] 15 developed countries and 5 developing countries.

[60] The analysis is based on an index that is a weighted average of the devaluation rate against the US dollar and the percentage change in foreign exchange reserves.

[61] Statistically significant indicators include international reserves, credit growth, credit to the public sector, the real exchange rate, and domestic inflation but also - although to a lesser extent - trade balance, export

The approach adopted in Kaminsky and Reinhart (1996) is akin to that of KLR (1998) although the paper looks at twin crises. The probability of a currency crisis conditional on a banking crisis is compared to its unconditional probability, and vice versa for the conditional probability of a banking crisis. Results suggest that currency crises are usually preceded by banking turmoil and that the former exacerbate the latter.

2. 7. 5. Structural Approach

The structural approach investigates the economic structure of several countries to assess the vulnerability of their currencies to speculative attacks and therefore ranks them according to their vulnerability. Dornbusch, Goldfajn & Valdés (1995) (DGV) and Sachs, Tornell & Velasco (1996) (STV) can be classified under this approach. DGV is a broad exploration of the behaviour of several economies (Argentina, Brazil, Chile, Finland and Mexico) before and after periods of extreme pressure in the foreign exchange market. The study aims to identify early warning signals of crises looking at the real exchange rate, inflation, the trade balance, international reserves, credit growth, the fiscal deficit/GDP ratio, the current account/GDP ratio, real interest rates, GDP growth and the ratio of debt to GDP.

STV develop a cross-section study (no historical information is used) to analyse the repercussions of the Mexican crisis on a fairly small sample of similar emerging markets in 1995 -the so-called tequila effect. The definition of a crisis is based on an index that is the weighted sum of the percentage exchange rate depreciation and the percentage loss of foreign exchange reserves as in KLR. STV, as opposed to KLR and Frankel & Rose (1996) who use a very large and diverse sample, focus on a few crisis episodes and a small set of indicators. Results reveal that the size of the current account deficit, the fiscal deficit and the amount of capital inflows are not relevant in explaining the 1995 crises. On the other hand, an overvalued real exchange rate, a large expansion

performance, money growth, real GDP growth and the fiscal deficit. By contrast, variables associated with the external debt profile and the current account balance do not perform well.

of bank credit and a low level of reserves were important elements during the financial crises[62].

Berg & Patillo (1998) evaluate the forecasting adequacy of three econometric methods using the example of the Asian crises. The three methodologies are those used in Kaminsky et al. (1998), Frankel & Rose (1996) and Sachs et al (1996). It is found that, using the models with historical data up to late 1996, one would not have been successful in predicting the timing of the 1997 crises accurately in the sense that false alarms outnumber correct warnings. Estimates reveal however that the KLR method performs well in ranking countries by probability of crisis in 1997.

2. 7. 6. Markov Regime Switching Models

Hsieh (1994) estimates an AR(4) version of Hamilton's (1989) Markov regime switching model to identify periods of speculative attack on EMS currencies from 1979 to 1993. Hsieh's second objective is to compare his classification of crisis episodes using three time series -i.e. changes in the exchange rate, in reserves and in the interest rate differential- to that of Eichengreen et al. (1995, 1996) who use an index composed of those three series. As in the original Hamilton model, the autoregressive coefficient and the transition probabilities are assumed constant. It is found that the model captures actual realignments as well as most of the crises identified by Eichengreen et al.

Gomez-Puig & Montalvo (1997) construct an indicator to assess credibility in the EMS. The indicator is the interest rate differential[63] modelled as a regime switching process. Two periods are investigated: January 1990 to July 1993 and January 1990 until March 1995 although the results are similar for both samples. The regime switching model is an AR(1) process[64], although an ARCH switching model is applied to the Spanish peseta[65]. As in Hiesh (1994), the transition probabilities are assumed to be constant and the objective is only to identify periods of high and low credibility. The indicator seems

[62] Note that Corsetti, Pesenti & Roubini (1998) extend the framework proposed by STV.
[63] These are weekly three-month interest rate differentials for all the EMS currencies - but the guilder, punt, and sterling -with respect to the German mark.
[64] The autoregressive coefficient is assumed to be constant, as opposed to regime dependent.
[65] The AR(1) process and switching ARCH provide the same conclusions for the peseta.

to predict the peseta, lira and escudo crises of 1992 more than a month ahead. The results suggest that most currencies only regained credibility after August 1993, but renewed tension emerged in January-March 1995.

Tronzano (1999) applies a switching model with time-varying transition probabilities to the one-month nominal interest rate differential between Italy and Germany, using monthly data from January 1990 until August 1995. An AR(1) specification with a unique state-independent variance is chosen (note that Tronzano does not present any specification tests to justify the model and that the justification for using a constant variance is that no convergence could be achieved with state dependent variances). Given the limited data span, Tronzano identifies only two periods when the level of the interest rate differential is high (i.e. the lira is less credible): the first quarter of 1991 (which is not justified) and the period between July and October 1992. Results suggest that the inflation differential between Italy and Germany, domestic credit growth, the rate of domestic credit expansion, and the level of foreign exchange reserves do not have any significant influence on the transition probabilities. On the other hand, output growth (proxied by changes in industrial production) significantly affects transitions from both the high and low credibility regimes, whilst the real exchange rate and the current account balance affect shifts from the high credibility state.

Martinez (1999) applies a regime switching model with time-varying transition probabilities to reserves, exchange rates and interest rates on EMS countries during the period 1979-1993. The transition probabilities are allowed to be time-varying logistic functions of fundamentals consistent with the first generation approach to currency crises as well as expectations proxies. The fundamentals are lagged one month and include domestic credit growth, the ratio of imports to exports, the real exchange rate, the unemployment rate and the fiscal deficit. Expectation proxies are interest rate differentials and survey data on expected exchange rates. Two switching models are estimated. In the first, an AR(4) switching model, a speculative attack is defined as a significant exchange rate depreciation. In the second, a speculative attack is determined by changes in the exchange rate combined with a fall in reserves and an increase in the interest rate differential using a VAR switching model. Furthermore, the autoregressive coefficients are dependent on the regime in both models. Because of the large number of parameters in both models, the data for the seven countries examined have to be pooled in order to identify the relatively small number of switches between regimes. The first model suggests that the probability of staying in a tranquil regime is negatively influenced by an increase in the interest rate differential and positively affected by the government surplus whilst the probability of staying in a crisis regime is not determined by any of the variables examined. Results were unchanged when country-specific dummies were introduced in the model. Although the second model rejects the hypothesis that all the explanatory variables are jointly insignificant, no variable is individually significant. However, allowing for country specific effects by use of dummies, the results show that the government budget deficit significantly influences the probability of switching from the tranquil state. Furthermore, Martinez compares the classification of crisis episodes derived from the two regime switching models to that of Eichengreen et al (1995, 1996). The first model provides a decent classification only for Italy, Spain and the UK whilst the second -VAR- model captures all the episodes identified by Eichengreen et al. -to the exception of Denmark. Overall it appears that the estimation of the three series -changes in the exchange rate, reserves and interest rate differentials- gives better results than the exchange rate only.

2. 8. Empirical Work on Specific Theoretical Models

2. 8. 1. First Generation Models

The early work by Krugman (1979) and Flood & Garber (1984a) emerged in response to currency crises in developing economies such as Mexico (1973-1982) and Argentina (1978-1981). The basic reasoning of the theory is simple. Any exchange rate that does not equal or exceed the shadow exchange rate -i.e. the exchange rate that would prevail if the foreign exchange authority had exhausted its stock of international reserves and allowed the exchange rate to float freely- will be profitably attacked by speculators. In other words, a balance of payments crisis is the equilibrium outcome of the maximising behaviour of rational agents faced with inconsistent exchange rate and monetary policies.

Two major empirical implications follow if the basic model applies: that is, expansionary fiscal and monetary policies prior speculative attacks, along with a steady erosion of reserves. Speculative attack models[66] endogenously predict the timing and probability of a crisis, and characteristically forecast lower bounds for the post-collapse exchange rates. However, the probability of a regime switch is derived on the convenient assumption that the authorities allow their reserves to be exhausted before switching to a floating regime. This assumption needs be modified for empirical purposes.

The experience of certain countries -notably Italy and Spain, where overvalued currencies and trade deficits were the result of inflation rates higher than in Germany for years- seems to be consistent with the predictions of Speculative Attack models. So far, these models have not been applied to particular 'crisis' episodes in the ERM. Indeed, Speculative Attacks have come to be associated with developing countries.

Blanco and Garber (1986) offer the first empirical application of the speculative attack theory, by developing an empirical method that predicts the timing and extent of devaluations forced by speculative pressure against currencies in fixed exchange rate systems. This is done by extending the Krugman-Flood-Garber model of speculative attack to the problem of recurring devaluation. A first basic assumption of the model is that the government's fiscal policy and implied deficits are its primary goals. That is, when the requirements to maintain these goals pass some limit on the central bank's net foreign reserves, then the government will renege on its fixed exchange rate policy.

After an attack, the central bank selects a new rate equal to the minimum viable rate plus a non-negative quantity depending on the magnitude of the shock that drove to the devaluation[67]. Agents are assumed to form expectations of future exchange rate changes from the average of the current fixed exchange rate and the rate expected to materialise, conditional on a devaluation, both weighted by their probability of occurrence. Thus, the primary inferences of the model are the one-step-ahead devaluation probability, as well as the conditional, and unconditional, expected exchange rates.

[66] See, *inter alia*, Flood & Garber (1984a), Obstfeld (1984) and Connolly & Taylor (1984).

[67] If devaluation -rather than a total switch to floating regime- occurs, the exchange rate will be moved to a position where it equals or exceeds the shadow floating rate.

The estimation proceeds in several stages. First, estimate parameters from the money market. Secondly, use an initial guess for the level of international reserves at which the monetary authorities would abandon the fixed rate regime if attacked. Since the second stage was initiated by a guessed value of the level of reserves at which the switch would occur, the estimate from the second stage is taken as the initial guess for the third stage. The iterative procedure is pursued until the guess and the revised estimate converge.

Blanco & Garber (1986) illustrate the applicability of the method by analysing the behaviour of the Mexican peso from 1973 through 1982, a period marked by a series of balance-of-payments crises. Hence the computation of conditional exchange rate forecasts and a time series of one-step-ahead devaluation probabilities, with observations taken from both fixed and devaluation sub-periods. According to the authors, results are promising, for estimated probabilities of devaluation in the next quarter -which range from less than 5 percent in early 1974 and late 1977, to more than 20 percent in late 1976 and late 1981- reach local minima in periods following the devaluation and local peaks at times of devaluation, as predicted by the theory.

Yet, Goldberg (1994) argues that, although studies such as that by Blanco & Garber (1986) "provide evidence for the qualitative and intuitive success of applying linear discrete time models, the results can be improved upon". These improvements relate to the use of strict assumptions such as Purchasing Power Parity, Interest Rate Parity, and the unresponsiveness of the demand for real balances to currency substitution motives. The economist thus applies the Goldberg (1991) modification of the Flood & Garber (1984a) model to search for the different forces that triggered the speculative attacks against the peso in the 1980s[68]. As in Obstfeld (1986), a speculative attack is supposed to take place as follows. If the central bank's difficulties are the outcome of a fundamental disequilibrium (i.e. large domestic credit expansion during a prolonged period), doubts arise about the sustainability of the pegged exchange rate and a speculative attack ensues. Furthermore, speculators may fulfil their own expectations by exhausting the central bank's international reserves stocks and initiating the fall of the fixed exchange rate. Under domestic currency convertibility, if agents, united, are

[68] The sample includes data form 1980:12 to 1982:9, and thus overlaps with that of Blanco and Garber, 1980:IV-1982:III.

powerful enough to deplete the existing stock of foreign exchange reserves to its minimal level, speculators will attack reserves at the moment such behaviour is expected to yield profits. The probability of a successful speculative attack in the beginning of the next period -using information at present time- is defined as the probability that the expected post-attack exchange rate will exceed the controlled exchange rate. The current period controlled exchange rate the equals that of the next period when the exchange rate is fixed or, alternatively, some other pre-announced or bounded level, when the exchange rate follows a crawling peg.

Empirical work includes the estimation of the money demand, the stochastic process followed by domestic credit, foreign capital shocks and deviations from PPP. It also comprises forecasts of the variables taken to be non-stochastic. To estimate the money demand equation, it is necessary to specify the lowest critical stock of international reserves that the central bank will accept to endure in any period. The complete model is actually estimated for a large range of reserve floors, including negative ones so as to account for the fact that the central bank may resort to emergency lines of credit[69]. The model -albeit sensitive to the perceived reserve floor- is helpful and accurate in predicting the speculation against the peso. Results show that the most important influence on the credibility and maintenance of the Mexican fixed exchange rate during the 1980s was the expected pattern of domestic credit creation, as opposed to foreign monetary/fiscal shocks. It is moreover revealed that the magnitude of the speculative attacks against the Mexican currency could have been lessened provided more frequent small realignments had been implemented.

2. 8. 2. Second Generation Models

The basic hypothesis of the second generation literature is that the durability of the peg depends on the speculators' expectations about the government's incentives to sustain this peg which, in turn, are partly contingent on the relative performance of the domestic fundamentals[70]. Presumably therefore, one of the reasons for the lack of empirical work on these models is that they generate crises through self-fulfilling expectations and

[69] Recall that Blanco and Garber (1986), by contrast, model the reserves floor as a constant multiplied by an index of US import prices.

game theoretic dynamics. This being said, second generation models concede that fundamental macroeconomic variables are not external to the onset of the crisis but, on the contrary, endogenously determine the regime shifts in exchange rate policy and therefore set limits to the possible equilibria. Yet, it is difficult if not impossible to isolate empirically self-fulfilling elements in currency crises. It does not really help to know whether an economy is under strain or whether fundamentals follow a deteriorating trend. Besides, the literature does not provide strict guidance regarding the choice of leading indicators for crises. Nor does it suggest the exact conditions as to the joint behaviour of macroeconomic and financial variables before, during, or after crisis periods.

Jeanne (1997) provides us with a stylised model of currency crisis that characterises the non-linear relationship between realignment expectations and the fundamentals, and formulates how self-fulfilling speculation may arise. In the proposed model, the relationship between devaluation expectations and the fundamental may display two different patterns corresponding to two conflicting theories of currency crisis; i.e. the fundamentals-based argument and the self-fulfilling speculation hypothesis. More precisely, when the fundamental is good, and when it is bad, the devaluation probability is uniquely established at a low and high level, respectively. On the other hand, as soon as the fundamentals lie beyond a certain frontier, self fulfilling speculation occurs and multiple equilibria emerge.

Testing the model then requires evaluating how the state of the economy is selected in the presence of multiple equilibria. Jeanne (1997) uses Dagsvik & Jovanovic's (1994) methodology, thereby assuming that the selection mechanism follows a Markov process that is independent of the fundamental. The test is applied to the case of the French Franc using monthly data from January 1991 to July 1993. The "fundamental" is a combination of the real exchange rate, the trade balance GDP ratio, and the unemployment rate. The devaluation expectation is measured using Svensson's (1993) drift-adjustment method[71]. It is found that the fundamental remains high enough to prevent self-fulfilling speculation up until August 1992; but then goes into the critical

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[70] Performance relative to other countries' and relative to the past performance of the domestic economy; where the 'fundamentals' may, *a priori*, comprise any macroeconomic variable

[71] See Chapter 6 for details of the methodology.

range where self-fulfilling speculation may take place. Further, results from the estimation of the state transition matrix show that self-fulfilling speculation was indeed very likely to occur. There is, therefore, a high probability that the economy was in a state of crisis, notably in September 1992, and during the first quarter of 1993 crisis. Results also reveal that the model performs significantly better than a linear regression of the devaluation expectation on the fundamental. Finally, the macroeconomic variables have the expected signs and two - the real exchange rate and the unemployment rate - are statistically significant.

In a related paper, Jeanne & Masson (1998) ask whether a currency crisis is a sunspot equilibrium; that is, whether an extrinsic variable influences the equilibrium outcome in the exchange rate market by co-ordinating the private sector expectations. They build a model of fixed exchange rate with an optimising policymaker in which multiple equilibria may take place in a similar framework as Jeanne (1997). At the empirical level, Jeanne and Masson (1998) use a simple version of the Markov regime switching model to allow for self-fulfilling jumps in the beliefs of foreign exchange market participants. It is showed that the Markov regime switching model can be used as a linearised reduced form of the structural model with sunspots. Linearising the equation for the endogenous devaluation probability gives: $\pi_t = \gamma_{s_t} + \beta' x_t + v_t$, where π_t is the devaluation expectation, γ_s is a constant that depends on the state, $\beta = (\beta_1, \ldots, \beta_k)'$ is a vector of coefficients, χ_t is the vector of variables that matter to the policymaker, and v_t is an i. i. d. shock[72]. Jeanne & Masson therefore assume that the devaluation expectation follows a Markov regime switching model with *n* states where only the constant term varies across states[73] and the transitions across those states correspond to shifts in expectations in their sunspot model.

The model is applied to the French franc experience between February 1987 and July 1993. Realignment expectations are measured using the drift-adjustment methodology and the vector of fundamentals includes the trade balance, the real exchange rate, unemployment and a time trend assumed to capture reputational issues. The constant term in the devaluation expectation equation is assumed to take two values

[72] All terms can be expressed as functions of the structural parameters of the model.

[73] That is, the coefficients on the fundamentals are maintained constant.

corresponding to high and low expectations of devaluation. As a benchmark, the equation is also estimated using ordinary least squares (i.e. assuming a unique equilibrium or one state for the constant). It is found that whilst the linear regression does not capture the known episodes of speculation, the Markov model does provide consistent results, where both states are persistent, the coefficients on the fundamentals display the expected signs and are statistically significant (except for the real exchange rate). Note, finally, that the authors' suggestion for future research is that it would be interesting to investigate what economic and political factors might influence the transition probabilities, a suggestion that is taken up in later chapters.

Masson (1998) proceeds to simple data-based calculations to identify possible contagion effects in a model of balance of payments crisis. The question is whether fundamentals were in the region where multiple equilibria are possible. Results show that monsoonal channels as well as spillovers did not play any role in late 1994 till early 1995 at the time of the Mexican crisis, and in the second half of 1997 and early 1998 during the Asian crisis. However, it is found that pure contagion and therefore sunspot equilibria can account for the waves of pressure in emerging markets during the Mexican and Thai crises.

2. 9. Conclusions

Chapter Two has shown that, whilst a first theory of currency crisis was developed in 1979 and new hypotheses emerged in the mid-1990s, the empirical literature on currency crises is extremely recent[74]. In that sense, therefore, an important challenge of this chapter was to unravel the intricacies of the latest literature and derive conclusions for potential new research.

Casual observation of the foreign exchange market suggests that crises are not all alike. Examination of the literature, with its numerous theories and its diversity of empirical results, reinforces the view that one cannot generalise about currency crises. Clearly, the newer generation of currency crisis models provides theoretical ground for fresh

[74] The exception is the few studies of the Mexican Peso in the context of first generation models.

hypotheses to be tested that perhaps depict the ERM experience more accurately than the older literature. Yet our analysis revealed that both views about currency crisis are theoretically attractive and equally relevant. In fact, the two strands may actually augment each other in that economic fragility can lead to self-fulfilling attacks and, conversely, self-fulfilling types of crisis can result in fundamental imbalance.

Evidence to date reinforces the view that crises are heterogeneous across currencies and difficult to predict. Whilst some crises might have been foreseen - as, for example, in developing countries - others clearly came as a surprise. Most studies suggest that some macroeconomic indicators determine currency crises. Factors often cited include high interest rate differentials, real exchange rate appreciation, foreign reserve losses, deterioration of foreign asset positions, expansionary fiscal and monetary policies. However, existing evidence as to the genesis of exchange rate crises is not robust. As far as forecasting is concerned, leading indicator models are still in their infancy. Although theoretical models characterise equilibrium situations successfully, they lack informative content as to the dynamics that lead from one equilibrium to another. As a result, a common opinion is that researchers' efforts to predict the timing of financial crises accurately may be in vain.

Inspection of the progress of the currency crisis literature leads us to conclude that evidence is yet to be found on the reasons why -and the conditions in which- certain ERM currencies were attacked successfully, while others were not. Aside from two studies reviewed in this chapter[75], the lack of effort gone into studying the ERM crises using specific theoretical models has left the ultimate nature of the ERM collapse ambiguous. Formal tests of the different hypotheses that derive from old and recent models of foreign exchange crisis, plus a comparison of the results for European currencies, seem essential to improve our understanding of the sources of speculative pressure. In addition, it appears important to contemplate the potential non-linear nature of the relationship between currency crises and economic fundamentals[76]. Finally, a

[75] Jeanne (1997) and Jeanne & Masson (1998).

[76] Jeanne & Masson (1998) stress the empirical fact that their non-linear model performs much better than a linear framework. Moreover, other studies have generally failed to identify any systematic linear relationship between currency credibility and economic fundamentals (Chen & Giovannini (1993), Thomas (1994), and Rose & Svensson (1994, 1995)).

caveat of the multiple equilibria explanation -i.e. the fact that it does not explain the process through which the equilibrium is selected- points to the need to explore the interaction between the government and the public. One approach is to consider the role of political incentives -such as the coming of elections and changes in government- in economic policy decisions.

APPENDIX 2: Sunspots

The concept of sunspot equilibria is often used in studies of excess volatility in asset prices but also of speculative and business phenomena[77], whereby prices and economic activity fluctuate randomly although no movement in the fundamentals of the economy can be perceived. This view attributes these fluctuations to random waves of pessimism and optimism unrelated to fundamentals. For example, Keynes (1936) developed the concept of "animal spirits" to describe irrational markets driven by herd. Keynes' adage was that the stock market was almost a beauty contest in which judges picked who they thought other judges would pick, rather than who they considered to be most beautiful. Cass & Shell (1980) were the first to employ the name "sunspot" to describe these psychological factors and their consequences on the economy, although the name had already been used by Jevons (1884) to describe his belief that solar activity influenced climate conditions and thus had effects on farm output.

Azariadis (1981) and Woodford (1988), among others, revived the idea and referred to sunspot equilibria to show the consequences of animal spirits on rational-expectations equilibria. The basic argument goes as follows. Expectations about, say, the rate of return of an investment, are conditioned on some arbitrary extraneous random variable and can be self-fulfilling. The market believes that this random variable signals future changes in the rate of return, so that if it rises unexpectedly (i.e. if animal spirits rise) the market reactions will make the rate of return rise, thereby confirming the initial expectations.

We follow the demonstration of Azariadis (1993) to review the circumstances in which the concept of sunspots was developed. Azariadis takes the example of dynamical rational expectations equilibrium satisfying a vector difference equation of the form:

$$E(x_{t+1}/I_t) = f(x_t, \mu_t) \tag{A1}$$

where x_t is the value of the state vector realised at time t, the left-hand side of the equation is the mathematical expectation of the state vector at time $t+1$ conditional on a common information set I_t, f is an appropriately defined continuous nonlinear map, and μ_t is the realisation of the possibly random parameter vector drawn from a well-defined

[77] See Howitt & McAfee (1992) for example.

unchanging parameter space. The information set, I_t, captures the entire history of the economy up to date t-1, it contains x_t and the public knows that it is the set on the basis of which all expectations are formed.

Taylor (1977) remarked that, given the history of an economy up to time t, equation (A1) gives the expected value of the state vector in period t+1, but does not determine higher levels. Define ε_t as an arbitrary random variable independently and identically distributed on a narrow interval [-a, a] about zero, with zero mean. Equation (A1) has an infinite number of solutions that take the following general form:

$$x_{t+1} = f(x_t, \mu_t) + \varepsilon_{t+1} \tag{A2}$$

If the economy described in equation (A1) has a stationary deterministic structure of population, endowments, preferences, and production sets, the parameter vector, μ_t, is then a constant. Therefore, any randomness left in the solution to (A2) necessarily hails from extraneous or psychological factors.

Chapter 3

Chronology of the EMS

3. 1. Introduction

Changes in the central parities have represented an institutional reality in the history of the ERM since its very early stages. During the period 1979-1983, the large exchange rate movements were mainly due to differences in members' willingness or ability to accommodate their currencies and respond to global shocks such as the 1979 oil crisis[1]. During that period, four out of seven realignments affected all ERM currencies[2] and all the adjustment were devaluations against the German mark. From 1983 to 1987, the system settled down and the four revaluations of the German mark in that period (out of which two were general realignments) were of much smaller magnitude[3].

From the beginning of 1987 until the autumn of 1992 -the so-called hard ERM episode- no change of the central parities proved necessary and currency realignment clearly became unpopular. Meanwhile, there was a clear downward convergence of the members' inflation rates[4]. Yet, several ERM currencies suffered severe mayhem in September 1992 and in the first half of 1993, before pressure ultimately culminated in heavy speculative attacks on several currencies to end with the so-called collapse of the ERM.

This chapter aims to provide an informal analysis of the ERM history as from March 1979 until December 1996 with a view to shedding some light on the macroeconomic and political causes of the turbulence in the system. Another objective is to highlight which models are likely to explain the events the best. Furthermore, the chapter sets up

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[1] The 1979 oil crisis led to a deterioration of the EMS member countries' terms-of-trade and also encouraged inflation.

[2] The November 1979 realignment concerned the Danish krone only. In March 1981, the Italian lira was the only currency to be devalued and in February 1982, the adjustment affected the Belgian franc and Danish krone. The other realignment involved all the ERM currencies, except the Dutch guilder that was devalued only on two occasions.

[3] Individual realignments, which involved only one or two currencies, were typically due to specific national circumstances, as opposed to collective responses to global shocks or fundamental macroeconomic discrepancies between members.

[4] The European average consumer price index fell from 6.3 percent in the early 1980s to 4.6 percent in the last three years of the decade.

a framework that will allow us to compare the actual experience of the ERM -and more particularly that of the French franc and the Italian lira- with the empirical results obtained in subsequent chapters.

For example, an important characteristic of the 1979-1987 period is the small amount of intervention by the Bundesbank. Indeed, intervention by the German central bank took place mostly outside the EMS and in dollars. In fact, the most significant interventions in the ERM (including the Bundesbank's) occurred in the peaceful period 1986-87, following the eleventh ERM realignment and capital market liberalisation. Furthermore, another predominant feature of the ERM is that movements in the mark/dollar exchange rate generally preceded realignments (the importance of shocks to the mark/dollar exchange rate however declined after the early 1990s).

Section Two is a survey of the significant events that struck the European Monetary System and its members at particular times between 1979 and 1993. In Section Three, special emphasis is put on the unprecedented episodes between the summer of 1992 and the summer of 1993. Section Four offers a summary of the events that post-date the crises. Section Five concludes.

3. 2. The 1992-1993 Crises

The circumstances of the early 1990s crisis period for the ERM can be summarised as follows: The Finnish markka was the first currency to be attacked before market pressure rapidly transferred to the Swedish krona. On September 16-17 1992 the pound Sterling and the Italian lira were forced into a withdrawal from participation in the ERM. On September 17, the Spanish peseta was devalued by 5 percent. Thereafter, other currencies -namely the Belgian and French francs and the Danish krone- also became targets for speculators (although maybe with different motives). Pressure spread from one currency to another in serial fashion[5] and, despite the French *Oui* to the Maastricht Treaty, intensified until August 1993 when most fluctuation bands were enlarged.

3. 2. 1. The Italian Lira

The weakness of the lira seemed to date from the day the unexpectedly negative outcome of the Danish referendum was known. Indeed, questions emerged as to the implications of the Danish *Nej* and the lira started to fall on June 3, 1992, first trading day after the referendum. Italian bankers and businessmen became concerned that the Danish rejection would slow the process of European integration and weaken the Italian authorities' determination to solve the problem of deteriorating public finances. Surprisingly enough, Ireland's ratification of the Treaty on June 18, 1992 did not help significantly to change expectations (more precisely, the lira strengthened very slightly afterwards). In August, markets became seriously perturbed by irresolute opinion polls as to the result of the French September referendum. On August 28 therefore, when it appeared that the French would reject the Treaty, the lira was pushed to its floor against the mark. And, on the August 31st, when J. Delors announced he would resign in case of a French *Non*, the lira slid even further down.

Italy -as opposed to the countries whose currencies were shaken in that period- had been showing unambiguous evidence of deteriorating international competitiveness. The analysis of various indexes indicate a loss of competitiveness of some 20% between 1988 and 1993[6] (a result confirmed by Italy's deteriorating current account and business profitability). External equilibrium -under conditions of permanent current account deficits- was pursued by stimulating capital inflows of two forms: bank foreign exchange liabilities and highly liquid government securities (underwritten by foreign investors). "After a strong rebound in the first quarter of 1992 the rate of economic expansion slackened considerably in Italy in the second half of the year. The backdrop of this development was the introduction of tough fiscal policies and the turbulence in the financial markets. Business and consumer confidence deteriorated strongly after the summer. [...] In the second half of 1992, fiscal policy embarked upon a major programme to curb the huge budget deficit and reduce public debt in the medium term. The backdrop to this move was the growing crisis of confidence in the international

[5] Isard (1995).

financial markets triggered by a large budget overrun in the first half of the year and lingering doubts about the possibility of the country being able to meet the Maastricht convergence criteria." United Nations report, 1992.

Hence, lack of credibility was clearly felt in the lira central parity. The Italian authorities' failure to reduce the ratios of public deficit and public debt to GDP constituted major focal points for speculators[7]. With a debt-to-GDP ratio exceeding 100 percent and significant amounts of debt being short-term, every percentage point increase in the Banca di Italia discount rate added 13 trillion lire to the budget deficit. Notwithstanding, the Bank of Italy constantly stubbornly linked the ITL credibility with the urgency of a scheme to restore equilibrium in public finance accounts, whilst high domestic interest rates, in the meantime, generated capital outflows due to interest payments. The Lira's stepping out of the ERM was associated with one of the largest devaluations against the DEM and the FRF that had ever been recorded in the lira's history. As compared with the 1991 average exchange rate to the DEM, the depreciation ranged from 17% in the fourth quarter of 1992 to 26% in late April 1993 (with peaks exceeding 30%).

The severity of the crisis experienced by Italy can further be summarised with some data as follows. " In spite of the frequent rises in domestic interest rates in the period from June to September 1992, a leakage of official reserves occurred of about 57.2 thousand billion Lire, if valued at constant exchange rates (i.e. one thousand billion more than the increase in the official reserves which occurred throughout the whole five-year period from 1986 to 1990). Over 50% of the loss was concentrated in the month of September." Azzolini & Marani (1993). Technically, the primary determinant of this leakage was the international speculation acting through the Italian banking system. In the month of September alone, capital outflows amounted to about 26 thousand billion Lire through Lira currency swaps only. The Bank of Italy then acted as lender-of-last-resort, sterilising -at least in part- the monetary base outflows taking place

[6] Eichengreen & Wyploz (1993) present three competitiveness measures: bilateral unit labour costs relative to Germany, multilateral relative unit labour costs adjusted for the business cycle, and the ratio of traded to non-traded goods prices at home.
[7] Having said this, it was later held that the fundamentals that international agents were evaluating during the summer-fall 1992 were of 'real' nature and unrelated to the public deficit and debt.

as a result of changes in the official reserves. Still, the non-bank private sector also provoked capital outflows: whilst households re-allocated portfolios in favour of foreign assets; firms were more inclined to internationalise productive processes.

3. 2. 2. The French Franc

The franc, which was not protected by capital controls any more, also suffered speculative attacks during the September 1992 crisis. Indeed, speculation against the franc was just as severe as that which hit the Pound. Unlike Italy and the UK, however, France had had lower inflation than Germany, as well as respectable trade and growth performance. Moreover, the French government was fully committed to the exchange rate and competitiveness measures showed no sign of difficulties. Hence, unlike in the Italian and British cases, sharp rises in very short-term rates and massive (effectively unlimited) support by the Bundesbank considerably helped the Banque de France which, in the end, was not forced to devalue. Portes (1993) reports that rises in short-term rates were workable since, "given French institutional conditions, the authorities were able to limit the damage by stopping the commercial banks from passing on interest rate increases to commercial and personal borrowers". Portes also observes that "offshore-onshore differentials during the crisis period indicated that France still had some barriers to international capital flows."

Later in 1992 and early 1993, the recession-induced drop in public revenues, and a counter-cyclical rise in public spending and tax reductions induced an augmentation in the government budget deficit. The incoming conservative government, in May 1993, therefore implemented measures so as to restrain the PSBR. This is when a second round of instability hit the franc[8]. Facing a policy dilemma between the *franc fort* policy and the current high unemployment figures, the *Gouvernement Balladur* eventually opted for the franc fort, claiming that the relatively weak growth performance were the characteristics of an economy only experiencing a cyclical disturbance. After the departure of Italy and Britain from the ERM, the French public and foreign exchange traders seemed to believe that France was in a position of strength

[8] See Kregel (1994) for details.

vis-à-vis Germany who, for both internal and external reasons, needed to support the process of European integration. Against this background, French interest rates were reduced nine times between April and June 1993 -sometimes in conjunction with Franco-German political meetings. This successively provoked not only a reduction in German rates but also a strengthening of the Franc.

Balladur's popularity started growing during April and May, even though the deterioration in economic conditions had turned out to be more rapid than expected. In brief, the government budget deficit had reached 5-6% (about double what had been reported), the year-end estimate of the unemployment rate was revised upwards to 12.5%, and growth figures were expected to decline from -0.5 to –1%. On July 5, when the Banque de France imitated the Bundesbank and reduced its official intervention rate to 6.75%, French official rates had already fallen by 235 basis points over the period since the election. Euromarket short rates on the franc were lower than on the mark since May and, by the first week of July, French and German long-term bond rates were virtually equivalent. At that time, foreign exchange traders seemed to allow themselves to be bewitched by the reductions in French interest rates, notwithstanding the announcements of weak economic performance. The franc became elevated to the position of *co-anchor* whilst Balladur's dilemma of whether to support employment -for electoral reasons- or defend the franc ERM parity was resolved.

In July, however, the franc appeared to have lost the support of the foreign exchange traders. On July 8, the French National Statistics Institute made another announcement that the French economy was in decline. From then on, foreign exchange traders appeared to take the view that the economic conditions -clearly announced in April- no longer justified the policy of *franc fort*. "Just as quickly as the mark had been transformed from the assassin of the lira and Sterling into a candidate for depreciation, the franc underwent a similar transformation [...] selling pressure on the franc increased and it repeatedly hit its intervention floor as the time shortened to the fatal 'final' July 29 meeting of the Bundesbank's economic policy council." Kregel (1994).

3. 2. 3. The Pound Sterling

The British authorities started to ease monetary policy gradually from October 1990. Further interest rate cuts were implemented in the following months, so that the level of short-term interest rates in the summer of 1992 had fallen to 10%. Yet, this was still perceived as too high a level. Indeed, business bankruptcies and unemployment were on the upsurge. Banks were making property-related losses due to the ebb in the housing market and the consumers' confidence and financial position were severely affected. However, going below the then current level of interest rate (i.e. around 10%, as in Germany) was incompatible with maintaining ERM membership.

In 1992, whilst continental European countries were entering a period of economic stagnation, Britain had already (since mid-1990) plunged into one of the worst economic recession since the Second World War. Evidence of competitiveness problems however proves difficult to interpret for the UK. Sterling's real appreciation predated Britain's entry into the ERM in October 1990 and therefore it is possible to argue that the ERM floor of DEM 2.78 undervalued Sterling with respect to the DEM Purchasing Power Parity. By contrast, the other argument goes that Britain's crisis was the result of its decision to join the ERM at an overvalued rate, whilst an alternative explanation for the relapse in the current account in 1992 was the UK's competitiveness problem with the US dollar.

Yet, the divergence indicator for Sterling was out of its limits throughout most of August and September 1992 (the divergence indicator was based on the ECU parity so that when a currency's ECU rate diverged by more than 75% of its permitted fluctuation band, the country in question was supposed to undertake measures to correct the divergence). So, although the behaviour of the indicator does not mandate any policy response, markets were most certainly anticipating a shift in future policy. In addition, intense criticism was levied against the decision to maintain high interest rates in the face of an incipient recession. Against this background, the British authorities did not pursue the option of raising overnight interest rates; partly because they were not confident that high interest rates would succeed in quickly defeating a speculative attack; and partly because of the screams of homeowners.

In the final analysis, both the markets and government knew that this policy instrument could have practical limits[9]. To quote the Governor of the Bank of England: "...raising UK interest rates, when the economy was so weak and inflationary pressure so subdued would have been regarded as transparently perverse...[F]ar from adding to credibility, it was always likely to bring -indeed in the event it did bring- the latent pressure to a dramatic climax." When asked whether the Prime Minister could have made his determination clearer by raising British interest rates before "Black Wednesday", Soros -who bet that sterling would not keep above its floor in the ERM and made a billion dollars out of sterling's collapse in 1992- replied that this would have encouraged him to speed up sales, since he believed that the British exchange rate commitment was untenable.

3. 2. 4. Other ERM Currencies

Following the suspension of Sterling's membership in the ERM, the substantial appreciation of the Irish Punt led to "a sizeable deterioration in the price competitiveness of Irish industry, for which the UK market is a very important outlet. Against a background of high unemployment, the Irish central bank was forced to raise short-term interest rates to very high levels to defend the existing parity."[10] Besides, forty percent of Ireland's exports went to these EMS countries that had been forced to devalue by the end of 1992. Traders therefore seemed to attach relatively more importance to Irish fundamentals once the initial attacks had occurred and the punt had lost competitiveness. In that sense, Sterling's drop-out probably spread contagiously to result in a lack of confidence in the punt parity. Yet Sterling's crisis may not tell the whole story: "Moreover, Ireland removed its controls on January 1, 1993 and was forced to realign shortly thereafter. At the time of the crisis, Irish controls allowed domestic interest rates to be nearly 80 (annualised) percentage points lower than they would have been without controls, measured by the deviation from covered interest rate parity." Eichengreen & Wyploz (1993)

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[9] As a matter of course, this was illustrated by the Swedish ultimate capitulation in November 1992.

In Spain, the budget deficit and current account deficit were large, unemployment was on the upsurge, real interest rates were very high and the currency was perceived as overvalued by the early 1990s. The Spanish model was then viewed as characteristic of a government-labour agreement on wages, always excessive in view of the fixed exchange rate, with inflationary consequences insufficiently contained by high interest rates. In the meantime therefore, a bias was developing in the foreign exchange market, where the peseta had become soft relative to the mark. Clearly, the circumstances were thought to be propitious for realignment. As Dornbush et al. (1995) argues, the foreign exchange market "ultimately was waiting for events to force a speculative attack" against the peseta -and lira. Yet Portes (1993) believes that the Spanish peseta is the best example of dependence of the exchange rate on expectations rather than fundamentals. The peseta was at the top of its ERM band only days before it was attacked and eventually devalued, first by 5% in September and then by another 6% in November. Portes argues that considerable informal evidence was consistent with the Escape Clause approach. For example, the Spanish government proposed reductions in the rate of unemployment benefits on the eve of the crisis, provoking labour unrest. To stem speculation against the peseta, the authorities decided to partially re-introduce capital controls, which had only just been abolished. "If the markets had perceived that competitiveness problems were evolving over time, traders should have begun to sell pesetas in anticipation of future difficulties, driving the currency toward the bottom of its band before the fact. This did not occur." Eichengreen & Wyploz (1993)

The fact that the realignments of the peseta and escudo occurred together was no surprise, given that a considerable share of Spanish and Portuguese exports are shipped to Portugal and Spain, respectively. As it turned out, the Portuguese escudo even followed the same path as the Spanish peseta in that it was at the top of its parity grid for a long time -until it was devalued.

In Belgium and the Netherlands, the stance of monetary policy continued to be determined by the exchange rate target throughout 1992. As was the case for the NLG, the BEF was left unscathed by the turbulence in the foreign exchange markets.

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[10] United Nations report 1992.

Respective monetary policies were progressively eased from the Autumn of 1992 in line with, if not ahead of, the relevant decisions of the Bundesbank. Similarly, the Danish Krone primarily remained relatively unharmed by the September 1992 turbulence in the European financial markets. It is only after the flotation of the Swedish and Norwegian currencies in late 1992, and the subsequent loss in price competitiveness of Danish exports, that speculative pressure emerged against the krone, and led the authorities to gradually tighten the monetary policy. On the other hand, the Drachma -which was not a member of the ERM- came under pressure. Capital controls were then introduced in Greece to deter speculators.

3. 2. 5. Germany: Intervention and Foreign Exchange Reserves

It has been argued that the first generation approach provides a good explanation of the ERM crisis in the Autumn of 1992. The period leading up to the 1992 attacks against the lira and the pound indeed did involve a large and sudden loss of reserves for the respective central banks[11]. Yet monetary and fiscal imbalances -two features of first generation models- were not clearly perceptible in this period. On the other hand, critics of the first generation theory point out that, for countries that have access to capital markets, the assumption of an exhaustion of reserves which will bring about the collapse of the fixed-rate regime is difficult to maintain. Sutherland (1995) for example argues that in a world with a large capital market, it is not unreasonable to assume that developed countries can borrow reserves, i.e. hold a negative reserve level. In other words, the issue of reserves becomes a question of whether the countries whose currencies were exposed to speculative pressure had access to a limited or unlimited amount of reserves to defend their parities.

The basic Target Zone model and the so-called Second Generation models all implicitly assume unlimited reserves as long as an exchange rate peg is supported by the two central banks involved. Practically, the assumption of unlimited support to currencies approaching the weak edge of the band is compatible with the Act of Foundation of the

EMS. "Intervention shall in principle be effected in currencies of the participating central banks. These interventions should be unlimited at the compulsory intervention rates." (Document 8, Section I, Article 2.2). "To enable intervention to be in the Community currencies, the participating central banks shall open for each other Very Short-Term Credit Facilities, unlimited in amounts." (Document 8, Section II, Article 6.1). Clearly, support should be unlimited, and all the more so since the 1987 Basle-Nyborg agreement extends the access to Very Short Term Financial Facilities both in use and duration. In practice however, the contention is only true so long as the commitment on the Bundesbank's side to support the weak currencies is *bona fide*. With hindsight, scepticism about such commitment is supported by the following statement by the German Finance Minister in a hearing to the Bundestag in December 1978: "The Bundesbank has the responsibility to intervene, and the option not to intervene if it is its opinion that it is not able to do so." Hence, a fundamental aspect of the ERM crises possibly lies in the Bundesbank's attitude in the defence of the currencies assailed by speculators.

(i) The Unification

The idiosyncratic facts in the period surrounding Germany's reunification are the following. Both public spending and private spending rose sharply on the eve of unification. The latter because of the need for investment in infrastructure and the rise in unemployment benefit payments; and the former because of consumption smoothing in the East (in anticipation of higher real wages). Inflation crept from 1.3 percent in 1988 to 4.8 percent in March 1992. Hence, as the Bundesbank responded by its standard inflation-fighting policy, long-term interest rates in Germany increased by more than 200 basis points in the period from late 1989 to mid-1990, during which the DEM depreciated in real terms by about 8 percent. German monetary policy tightened even more sharply in late 1990 and short-term interest rates basically continued to climb until the crises burst.

[11] Daily foreign exchange transactions now exceed $1 trillion, a volume far larger than the reserves of any central bank. The largest private hedge funds -e.g. Soros Management and Tiger Management- manage enough investment capital to exhaust most central banks' reserves.

Moreover, the German investment and fiscal boom continued through 1991, whilst other EMS countries were slipping into recession. Meanwhile, in the United States, the recession was still biting despite the policy measures that cut the interest rate to 3 percent. An unprecedented gap of 6.75 percentage points developed between German and US interest rates, automatically inducing capital flows from New York to Frankfurt. As a result, market pressure started to get intense on ERM currencies relative to the DEM and expectations of realignment started to emerge. It was then widely argued that a real appreciation of the Mark -which the Bundesbank had requested as early as 1989- was required. As a matter of course, however, France vetoed any change in the franc parity relative to the DEM whilst Britain alleged that a downward realignment of the pound, soon upon entry, would undermine the credibility of its monetary policy. In the end no orderly realignment took place.

Yet, there are doubts that the reunification shock, combined with the Bundesbank's resolution not to inflate, had any influence on the timing of the 1992 crisis. Indeed, there is a problem of timing in the argument that the imbalances provoked by German unification destabilised ERM parities. That is, the crisis occurred two years after German unification took place in 1990. Portes (1993) writes: "Not dealing properly with the German shock was sufficient, but not necessary, for the EMS troubles. Had there been an appreciation of the DEM, it would have moderated inflationary pressures, and German interest rates would not have had to rise so far."

(ii) The Bundesbank's Stance in 1992

As mentioned above, the Bundesbank dutifully -though unsuccessfully- asked for a DEM revaluation, invoking the inflationary problems caused by German economic and monetary unification. It also fulfilled its intervention obligations in the summer of 1992, despite its inflation objective. It is only on September 11, after a day of massive and unprecedented purchases of lire, that the Bundesbank ultimately invoked its right to limit its intervention, on grounds of price stability. Meanwhile, it was perceived that the Bundesbank attached priority to the defence of those currencies that were pivotal members of the ERM and the convergence club -that is, the hard core French Franc and Danish Krone. "On August 25, R. Jchimsen, a member of the Bundesbank's policymaking council, suggested that a realignment could be in the offing. On August 28, J.W. Gaddum, a member of the seven man permanent directorate, expressed the view that there was no reason to cut German interest rates. On September 10, anonymous sources within the Bundesbank suggested that the pound should be devalued. On September 15, newspapers reported that sources in the Bundesbank had suggested a sterling devaluation could not be ruled out. And on September 16, H. Schlesinger was widely quoted as saying that Europe's financial difficulties remained unresolved. Each of these statements worked to destabilise weak EMS currencies." Eichengreen & Wyploz (1993)

Ex-post, the Bundesbank was therefore said to have betrayed the Italians and the British: "the former by promising (in exchange for devaluation) an interest rate reduction that turned out to be derisory, the latter simply by telling the markets that Sterling could not hold. In regard to the UK, the Bundesbank had never hidden its beliefs that a wide ranging real DEM appreciation -certainly including Sterling- was required. At worst, Dr Schlesinger was indiscreet in confirming that (yet again) when he did", Portes (1993). Comments by Soros corroborate the views presented above. Indeed, as Soros declared later, he was confident that the Bundesbank wanted devaluations in Britain and Italy, but not in France.

(iii) The Bundesbank's Stance in 1993

In 1993, on March 19, before the new French interest rate policy, the Bundesbank reduced the discount and Lombard rates to 7.5 and 9 percent, respectively. Then, given the persistent inflation and wage negotiations, rates were frozen up until April 23, when Balladur officially visited the Bundesbank. The latter was left with little room for manoeuvre in the face of the necessity to attract capital to finance the reconstruction of East Germany and the deterioration of domestic economic conditions. When the French called for a co-ordinated policy of rapid interest rate cuts, the Bundesbank clearly saw a danger for its own monetary policy objectives. Obviously, the reductions necessary for the French to initiate a policy of economic recovery were unacceptable for the Germans. Nonetheless, the market opinion developed that the reductions operated on the 2nd of July were indications of the Bundesbank's readiness to start reducing rates again. By then, the discount and Lombard rates had cumulatively[12] declined by 150 and 200 basis points, respectively, whilst repurchase rates and market rates were down by 250 and 300 basis points, respectively, and long-term bond rates had fallen by about 160 basis points (to around 6.5%).

Kregel (1994) therefore argues that, despite the accusations, the Bundesbank was not responsible for the excessively high European rates since, during the period of rate reductions, it either froze or moved them with reference to internal indicators. "In fact, the strength of the franc had nothing to do with the response of the Bundesbank and was completely dependent on the actions of the foreign exchange traders themselves". Subsequently, in July, when the two policy indicators used by the Bundesbank -i.e. the inflation rate and the rate of growth of M3- seriously worsened, and expectations *should have been* that there would be no further interest rate cuts, at least before September, the market confidently expected a 100 basis point reduction in Repo rates, stubbornly ignoring the bad economic news. As it happens, the Bundesbank did capitulate to expectations by reducing the Lombard rate by 50 basis points. Yet again, the market interpreted this as no reduction at all simply because it expected a cut in the discount rate, which had been left unchanged. Expectations reversed completely and massive sales of francs precipitated a currency crisis. "For economists who believe that the market is always right -that traders simply impose economic reality on politicians, that traders are rational users of economic information- there was a great deal of disappointment in the Silly Season of the Summer of 1993." Kregel (1994)

3. 3. The Aftermaths of the 1992-93 Crises

3. 3. 1. The Calm Period: Autumn 1993 - Fall 1995

In the one and a half years following the widening of the fluctuation bands, the EMS experienced a period of calm. Obviously, this contradicts early verdicts that the EMS was dead and that flexible exchange rates had arrived. Indeed, the European monetary authorities did not use the full extent of the wider bands, and volatility went down after

[12] That is, from July 1992 to July 1993.

the change in the system. Some even regard the serenity in the European exchange rate markets following the 1993 crisis as the indication that the markets acknowledged the tenability of the then parities.

France, in particular, did not abandon the austere monetary policy it had been pursuing in order to maintain a stable link between the FRF and the DEM. The French merely emphasised their commitment to the goal of EMU through the continuity in their domestic economic management and foreign policy. As regards the two 'ex-members' of the ERM, both the pound Sterling and the lira started to recover against the DEM in late February and late March 1993, respectively[13]. Interestingly enough, the recovery of the Pound proved larger and more durable than that of the Lira. Indeed, whilst the British authorities had opted for few, large interest rate cuts over a short period of time (i.e. the base rate was cut from 10 percent to 6 percent from mid-September 1992 to January 1993); Italy chose to spread them regularly over time. In the meantime, Italy was announcing its firm intention to re-enter the ERM; whilst Britain was making public its opposition to do so, in the course of the current legislature. It is thus surprising to observe that Italy turned out to be 'penalised' by far higher interest rates and wider long-term yield differentials against Germany than Britain. Britain even seemed to be 'rewarded' by being able to lower its interest rates towards -if not below- German levels by April 1993.

3. 3. 2. The Currency Turmoil of March 1995

Not only did the currency crisis that hit the ERM in 1992-93 seem to return with vengeance in March 1995, but it also extended way beyond Europe to involve the US dollar and Japanese yen, as well as the Mexican peso. Whilst the dollar reached post-war lows against the mark and yen on 6 March, a knock-on effect of the strong mark was felt by the other ERM currencies. The peseta and escudo were devalued, and the Swedish and French interest rates were raised to prevent further depreciation of their respective domestic currencies.

[13] Depreciations against the DEM had reached 17 percent for the Pound and 25 percent for the Lira. The effective loss resulting from the use of foreign exchange reserves to purchase Sterling amounted to one billion pounds but 15 billion of reserves were actually poured.

The speculative pressure on the dollar began in December 1994 following the economic crisis in Mexico as the prospect of a massive drop in Mexican imports was perceived as a severe hit for the USA's export recovery. Moreover, because German interest rates were seen as set to rise and US rates were expected to drop, investors moved into the stable mark and sold dollars. The wave of speculation continued as the Federal Reserve did not take any measure to defend the dollar, so that by early March the real value of the dollar was said to be 40 to 50 percent undervalued.

3. 3. 3. The Autumn of 1996 Events

The Finnish markka and Italian lira (re)joined the ERM on 14 October and 25 November, respectively. There was almost no market reaction to the largely expected move of the markka into the ERM. Finland's budget deficit had already been brought down and there was no serious controversy. The entry was only just a question of timing in the several weeks preceding entry. The lira's re-entry into the ERM was a long overdue process. On April 21, 1996, elections took place in which the centre-left Olive Tree alliance -headed by R. Prodi- gained supremacy in the Senate and majority in the Lower House. Compared to S. Berlusconi -from the right wing Freedoms Alliance- the newly elected party was perceived as relatively concerned with public finances. In other words, the results of the elections raised the possibility for the lira to re-enter the ERM and for Italy to qualify for EMU. Thus, after two days of intense negotiations in Brussels, the central parity for the lira was decided at 990 lira per mark after which the lira started to appreciate by 0.4 % in a week.

3. 4. Conclusion

In this chapter, the investigation of the significant ERM events has provided valuable information. Several crucial points have been touched upon. We have focused on macroeconomic aspects, with the competitiveness problems[14], the consequences of Germany's reunification, the policy conflicts during the hard ERM years and the pronounced fall of the US dollar in the summer of 1991 (plus the removal of capital controls). We have also highlighted political aspects and, in particular, the perceived weakening in ERM members' commitment to fixed parities following the Danish referendum in June 1992; and the market's scrutiny of the Bundesbank's attitude towards interest rates and intervention. Furthermore, the analysis has pointed out that arbitrary (self-fulfilling?) expectations possibly played a role in the 1993 ERM disruption, in that market expectations did not reflect obvious macroeconomic developments.

Yet the examination of the possible national macroeconomic imbalances in the relevant ERM member countries has not produced any clear conclusion as to the generation of the unprecedented crises (although Italy and the UK experienced specific policy tensions). In fact, no individual element seems to provide a flawless explanation of the crisis puzzle. As a result, we have been unable to derive a general interpretation of the ERM crisis on the basis of our event study. This leads us to argue that the sources of tension in the ERM were a combination of all the factors reviewed in this chapter. A theoretical framework for the ERM crises probably ought to combine the two existing strands of the literature; namely, the first and second generation models, and to depend on the currency under investigation. For example, Italy -with its high debt to GDP ratio and competitiveness problems- fits more in the fundamental based first generation models than France that depicted no significant monetary and fiscal policy inconsistency. It therefore seems that only empirical evidence can help in answering the question.

[14] Inflation differentials vis-à-vis Germany remained positive at least until 1991 when they converged towards zero for several countries.

APPENDIX 3: Chronology of the EMS Events

1979

March 13

The European Monetary System is instituted as a reaction to the high volatility of the European Community currencies during the 1970s. The initial currency weights in the ECU[15] - one of the two features of the EMS - are: DEM 32%, FRF 19%, GBP 15%, ITL 10.2%, NLG 10.1%, BEF 8.5%, DKK 2,7%, GRD 1.3%, and IEP 1.2%. On the same day, the Exchange Rate Mechanism -the most important feature of the EMS- starts to operate with seven currencies. The margin of fluctuations, above and below the bilateral central parities, for Belgium, Denmark, France, Germany, Ireland and the Netherlands is set at +/- 2.25 percent; while Italy is allowed to keep a 6 percent band until 1990.

September 24

First (modest) ERM realignment: DEM +2 % and DKK -5 %

November 30

Although the Danish krone is not under urgent pressure in the market, the Danish authorities ask for a second realignment to improve competitiveness: DKK -5 %.

1981

March 23

The Italian authorities request a third realignment: ITL - 6.4 %. Important intramarginal intervention is necessary to sustain the lira in its wider band.

May-June

The Franc declines in response to an upward move in US interest rates and to nervousness about the presidential and parliamentary elections in France (tensions are strongly associated with the Socialist victory in the second round of the Presidential elections).

October 5

[15] The ECU is defined as the 'basket' of currencies of the countries that are members of the EMS. Note however, that representation of a country's currency and participation in the ERM are independent.

Fourth ERM realignment. France and Italy decide to devalue their currencies (-3.3 % and -3.3 % each), while the DEM and the NLG are realigned upward (+5.5% and 3.5% respectively).

1982

February 22

Fifth ERM realignment. Belgium suffers high unemployment, a rising budget deficit and a large current account deficit and takes the initiative to devalue BEF by 9.3%. The Danish authorities ask for a 7% devaluation but the DKK is devalued by 3.1%. The FRF is not devalued despite increasing Franco-German tensions.

June 14

Sixth ERM realignment: DEM +4.25%; FRF -5.75%; ITL -2.75%; NLG +4.25%. The FRF is devalued, pushed in part by the strength of the dollar and waves of speculation that wash away more than two third of France's foreign exchange reserves. France then implements a temporary freeze of prices, wages, rents, and dividends until October, plus a reduction in the 1983 budget deficit plans.

December

Sterling's weakness raises questions about the stability of the Irish currency.

1983

March 21

Seventh ERM realignment: DEM +5.5%; FRF -2.5%; ITL -2.5%; BEF +1.5%, IEP - 2.5%; NLG +3.5%

March 28

The collapse of the FRF -presumably tracing back to an over-expansionary domestic credit policy- results in massive reserve losses and large-scale borrowing. A stringent austerity restraint is implemented. Expenditures are cut and taxes are raised to reduce the budget deficit; whilst foreign exchange controls are implemented to restore external balance.

1984

September 17

EMS revision of currency weights in ECU currency basket: DEM 32%, FRF 19%, GBP 15%, ITL 10.2%, NLG 10.1%, BEF 8.5%, DKK 2.7%, GRD 1.3%, and IEP 1.2%.

November

The GBP depreciates substantially against the dollar and the British government reduces interest rates in order to stimulate demand and prevent further rise in unemployment. This triggers off a massive selling of sterling as investors rush to buy soaring dollar.

1985

July 22

Eighth ERM realignment: the ITL is devalued by 8% against all other currencies.

1986

February

The Single European Act sets December 31, 1992 as the date for completion of the internal market with free movement of goods, services, labour and capital within the Community.

April 7

Ninth ERM realignment: DEM +3%; FRF -3%; NLG +3%; BEF +1% and DKK +1%. Pressure on the FRF mounts in the context of the French parliamentary elections of March that introduce the cohabitation between the two majority parties.

August 4

Tenth realignment. Ireland devalues the IEP by 8% in order to encourage exports. The government decides to tighten its monetary policy sharply so as to offset the destabilising effects of the GBP's weakness.

1987

January 6

The foreign exchange market is in turmoil after the USD's drastic fall and theDEM's strengthening in the ERM. The FRF falls to the bottom of the ERM grid, spurred by student riots and public sector strikes. The French government is unable to defend the FRF solely by monetary means.

January 12

An agreement is reached -in an eleventh and last ERM realignment- to revalue the NLG and BEF by 2% and the DEM by 3%, against the remaining currencies. Italy announces plans to liberalise its exchange controls. In fact, the 11th realignment of the ERM parities -unlike the previous- is caused by tensions on the foreign exchange market and by the weakness of the USD. It is barely complete before speculators begin betting on the next one although no major macroeconomic divergence is visible.

September 12

Basle-Nyborg Agreement of the Committee of Central Bank Governors to strengthen the ERM. Recommendations include wider use of fluctuation bands, small and frequent realignments, use of the ECU for intra-marginal intervention, and extension of the very short-term financing facilities.

1988

June 13

Agreement to free capital movements in the EC. Italy and France agree to remove major capital controls over the next two years. Germany softens previous opposition to a European central bank.

June 28

Hanover Summit. Britain rejects proposal for European central bank and single currency. The Delors Committee is created.

1989

April 17

The Delors Committee Report proposes a three-stage transition to Economic and Monetary Union.

Stage 1: Capital movements liberalised, ERM membership enlarged, more power to EC Committee of Central Bank Governors. Realignments still permitted.

Stage 2: Exchange rate band narrowed from +/- 2.25%, realignments permitted only in exceptional circumstances. Economic policy guidelines, not yet binding, set at the Community level. European System of Central Banks (ESCB) set up, absorbing existing monetary arrangements.

Stage 3: Exchange rates irrevocably locked. ESCB replaces the national central banks. Adoption of a single currency completes the process.

June 19

Spain enters the ERM with a wide fluctuation margin of +/-6%.

June 27

European Council decides to begin Stage 1 of the Delors plan on July 1, 1990.

September 21

Revision of currency weights in the ECU: DEM 30.1%, FRF 19%, GBP 13%, ITL 10.15%, NLG 9.4%, BEF 7.9%, ESP 5.3%, DKK 2.45%, IEP 1.1%, GRD 0.8%, and POE 0.8%.

November

Fall of the Berlin wall.

December

Strasbourg Summit. It is agreed that by December 1990 an intergovernmental conference would prepare changes in the Treaty of Rome needed for EMU. West Germany, who had favoured a slower pace, agrees because its partners approve to German monetary unification.

1990

January

Technical adjustment of the ITL: -3.7%, and narrowing of the band to +/-2.25%.

February 6

Sudden decision of Germany's Chancellor Khol in favour of rapid movement toward a German currency union.

March

French minister announces that the franc will never again be devalued within the EMS. European Commission releases its plan for EMU to be discussed by EC finance ministers on March 31.

March 31

Ashford Castle meeting of EC Finance Ministers. Eleven of twelve ministers agree on main features of the new European Central Bank.

April

German governments agree on the conversion and union, to be enacted July 2, 1990.

April 28

Dublin Summit. Declaration that changes to Treaty of Rome relating to EMU must be ratified by end of 1992.

May 18

Treaty to unify the two Germanies signed.

June

The Belgian central bank declares the DEM as its main official policy target.

July 1

Complete removal of all capital controls which, until then, permitted orderly realignments, especially in the later years of the period up to 1987, when the new bands created by realignments overlapped the old ones[16]. Exceptions include Ireland, Spain, Portugal and Greece, for whom the deadline is postponed to 1992.

July

Monetary union between West and East Germany.

August

European Commission finalises its contribution to the upcoming Rome conference on EMU. It proposes that existing currencies be replaced by the ECU. Stage Two should start in January 1993 and Stage 3 soon afterwards. Germany and the Netherlands favour convergence first and vote against any deadlines.

October 8

The GBP enters the ERM with a wide fluctuation band of +/- 6%.

October 22

The Norwegian krone is pegged to the ECU with a +/- 2.25 percent fluctuation margin.

October 27

Rome Summit. Breakthrough in favour of EMU deadlines. Eleven out of twelve agree that Stage 2 of EMU should begin January 1994. Countries will be permitted to stay outside Stages 2 and 3 if they choose.

November 13

EC central bankers declare the first objective of the European central bank as price stability.

November 22

UK Prime Minister Thatcher resigns.

December 14

Rome Summit. Intergovernmental conference on EMU begins work on a treaty to be signed by October 1991.

1991

April

Spain removes virtually all capital controls. There is speculation that Britain and Spain will narrow their exchange rate bands to +/- 2.25 %.

May 13

Reports that the Bundesbank's president will resign. Resignation officially announced on May 16.

May 17

Sweden links its currency to the ECU with a +/- 1.5 percent margin.

June 7

Finland unilaterally links its currency to ECU.

June 9

UK and German leaders agree to try to slow the pace of EMU negotiations in the next summit.

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[16] Indeed, controls -e.g. taxes on holdings of foreign currencies or restrictions on the ability of banks to lend

June 30

Luxembourg Summit takes no significant new step towards EMU.

November 15

Finland devalues by 12.3% against ECU.

December 9 & 10

Maastricht Summit.

1992

January 9

The pound has a bad day amid speculation of devaluation or ERM realignment. Reports are circulated that Margaret Thatcher has privately advocated leaving the ERM.

June 2

The Danish rejection of the Maastricht Treaty at the first referendum raises serious doubts about progress towards Monetary Union.

June 3

In the aftermath of the Danish vote, the French government announces that a referendum on the Maastricht treaty is to take place on September 20.

June 4

Italian long-term interest rates harden.

June 19

Irish pro-Maastricht vote does little to rescind market fears.

July 6

The Bundesbank raises the discount rate to 8.75%, but leaves the Lombard rate at 9.75%. The German-US short-term interest rate differential widens to 6.75 percentage points. The French finance minister Edmond Alphandéry invites his counterpart, Theo Waigel, to a meeting in Paris to discuss exchange rate issues. Waigel's alleged reluctance to the idea is interpreted in the markets as the beginning of the end of the Franco-German partnership.

July 10

abroad- were protecting central banks' reserves by limiting short-term speculative capital flows.

The speech by the Bank of England to European Policy Forum rules out every option other than keeping the pound in the ERM.

July 13 & 14

Central Bank governors meet in Basle. Sterling falls sharply against the mark due to speculation about a tightening of German monetary policy and political pressure on the British government.

July 16

Bundesbank raises the discount rate by 0.75 points to 8.75%. Italy follows suit.

July 16 & 30

Franco-German discussions over realignment. Britain signals willingness to consider general realignment.

August 20

The GBP falls close to its ERM floor.

August 21

The crisis begins as the foreign exchange markets induce a dollar fall to a historic low against the DEM, despite the intervention of eighteen central banks.

August 25

First French polls show majority *against* Maastricht.

August 26 & 27

The G7 deputies meet. Realignment is discussed.

August 28

Joint EMS statement that there will be no devaluation. Strikingly, the ITL is the first ERM currency to suffer adverse attacks. It falls below its ERM floor. The market uncertainty about the stance of the Bundesbank on realignment undermines the British authorities' heavy intervention to lift the GBP.

September 3

The UK government takes out a 10 billion ECU loan to add to foreign reserves. The GBP rises sharply.

September 4

A 1.75 point increase in the Banca di Italia's discount rate brings it to 15%, but the ITL remains below its ERM floor.

September 5 & 6

Meeting of EC officials in Bath. The UK government requests Germany to lower interest rates. The Bundesbank refuses, but promises not to raise them and warrants its support for ERM parities.

September 8

The Finnish markka is floated; whilst the Swedish marginal lending rate is raised to 75%.

September 9

The ITL comes under a wave of heavy selling pressure.

September 10

The Italian government takes on emergency powers to cut budget deficit.

September 12

Although the Italian central bank intervenes by buying ITL and increasing the domestic interest rate, it finally concedes a 7% devaluation in exchange for a 0.25% decrease in Germany's interest rate to 9.5%. The ITL moves to the top of its new ERM band.

September 15

The GBP and the ITL are sold heavily in foreign exchange markets. The GBP closes barely above its ERM floor.

September 16: "Black Wednesday"

In the UK, the Bank of England engages in massive intervention in support of the GBP, reportedly spending as much as $20 billion (half of its international reserves). The Minimum Lending Rate is raised from 10 to 12% and a further rise to 15% is announced. Despite all these efforts, the GBP is dropped out of the ERM at the end of the "Black Wednesday". Thereafter, as the Italian Lira falls again below its new ERM floor, the Italian authorities are also forced to suspend the ITL from the ERM. Finally, the Swedish Riskbank raises the marginal lending rate to 500%.

September 17

The ESP is devalued by 5 percent whilst the DKK and IEP fall to their ERM floor. The Bank of England reduces the Minimum Lending Rate in England to 10%. The GBP falls sharply.

September 18

The GBP ends the week 6% below its ERM floor.

September 19

Britain declares that the GBP will not go back in the ERM until it is reformed.

September 21

The French *Oui* has the edge on the *Non* at the referendum on the Maastricht Treaty. The French and German central banks intervene as the FRF plunges to its ERM floor.

September 22

The FRF remains weak and the Irish punt falls below its ERM floor despite intervention. The ESP and POE are ebbing.

September 23

Spain reinstalls capital controls. Intramarginal intervention by the Bundesbank and the Banque de France supports the FRF. The French official interest rate is raised to 13 %, the Banque de France suffers a loss of reserves of about FRF 80 millions while the Bundesbank also intervenes heavily.

September 24

The IEP remains below its ERM floor despite capital controls. Portugal also explicitly introduces capital controls.

October 6

By this date, the ITL and GBP are, respectively, down 22 percent and 14 percent of their August levels. Throughout October most countries whose currencies came under attack during the crisis gradually lower their official interest rates. Exchange rates nonetheless stick above their pre-crisis levels. Capital controls are partially removed in Spain.

November 19

New wave of speculation. The Swedish krone link to the ECU is suspended.

November 23

The POE -which had joined the ERM in April 1992 with a fluctuation margin of +/- 6 percent- is devalued by 6 percent, possibly as a consequence of the earlier erosion of price competitiveness. On the same day, the ESP is also devalued by 6 percent. Subsequently, Spain removes all restrictions on capital flows. The Bank of Ireland needs to raise its overnight rate to 100% between November 26 and December 2 to defend the IEP.

December 10

Norway suspends her link to the ECU.

1993

January 1

Ireland lifts all exchange controls in line with the requirements of the EC. The Irish central bank raises the official interest rate to 50% on January 6, and to 100% two days later. In mid-January, the rate is cut back before being raised again to 100% on January 28.

January 4

The FRF is once again quoted to its ERM floor. The Bundesbank and the Banque de France reiterate that they will intervene to defend the FRF.

January 30

The speculative pressure on the IEP, dating back to the wake of the flotation of the GBP in September 1992, persists so that the authorities agree to devalue the IEP by 10%, the largest devaluation since the establishment of the ERM.

February 4

The Bundesbank lowers the discount rate to 8.26% and the Lombard rate to 9%.

March 8

The Bundesbank lowers the discount rate again to 7.5%. The cut helps avert a possible new currency crisis following the French general elections of March 28 as the new Gaullist majority coalition is thought to be less pro-European than the outgoing Socialists.

April 13

The Banque de France lowers the official rate (and again on April 19 and May 6, 13 and 25).

April 22

The Bundesbank lowers the discount, and Lombard, rates to 7.25 and 8.5%, respectively.

April 27

New outburst of speculation. The ESP falls down to its new historic low since joining the ERM.

May 14

After a series of heavy attacks, the ESP and POE are devalued by 8 and 6.5 %, respectively. The European Ministers of Finance meet in Kolding and appear to be reasonably optimistic as to the future of the EMS.

May 18

The Danes ratify the Maastricht Treaty. The ERM ephemerally returns to stability.

June 14

The Banque de France lowers the official interest rate and embarks on an aggressive policy of interest rate cuts (again on June 21 and July 2).

June 24

The German mark falls against most major currencies as the German Finance minister cancels the Franco-German meeting to plan concerted interest rate cuts.

July 1

The Bundesbank lowers the discount and Lombard rates to 6.75 and 8.25 %, respectively.

July 9

The Banque de France intervenes to defend the FRF that, nonetheless, continues falling.

July 12

The Bundesbank announces that it will intervene to support the FRF as the latter falls close to its ERM floor.

July 22

During the last week of July, speculation reaches a climax, hitting the FRF, the ESP, the DKK and the BEF. Meanwhile, uncertainty emerges concerning the outcome of the next Bundesbank council meeting. The French official interest rate is raised again and the Bundesbank intervenes to support the FRF.

July 23

The Maastricht Treaty is ratified in the UK.

July 28

Against a background of depleting reserves and weakening public confidence in the parity, the Bundesbank invokes its right to limit intervention "*because doing otherwise would threaten price stability*". Devaluation expectations turn out to be satisfied by an 8% devaluation of the FRF against the DEM following the collapse. The Bundesbank decreases the Repo rate only slightly and leaves the other intervention rates unchanged.

The markets expect cuts in official rates at the next day's council meeting. The lower parity limit of the FRF (3.4305) is exceeded, in spite of massive interventions (300 billion francs).

July 29

The Lombard rate is down to 7.75 % but the discount rate is not changed. The Bundesbank intervenes to support the FRF and BEF, the DKK, as well as the ESP and the POE.

July 30

The BEF and FRF, and the DKK fall below their ERM floors.

August 2: Breakdown of the ERM

Against a background of heavy speculative selling pressures against the major ERM currencies[17] the decision is taken to widen temporarily the existing permissible fluctuation bands to +/- 15% on either side of the central bilateral parities, whilst keeping the latter unchanged. The only exception is the DEM/NLG exchange rate which, in a separate bilateral agreement between the two governments, is maintained within the old band of +/- 2.25%.

[17] Namely, the BEF, the DKK, the FRF plus the POE.

Chapter 4

Methodology and Data

4. 1. Introduction

Exchange rates typically exhibit calm periods followed by crisis periods (with volatility clustering). One way of modelling -capturing- these regimes is the Markov regime switching model. The following chapter proposes -and explains- this recently developed non-linear econometric methodology to estimate currency crises. The objective is to offer a new alternative estimation procedure that overcomes the problems commonly encountered in the empirical literature on currency crises.

Indeed, the Markov Regime Switching model (MSM) with Time-Varying Transition Probabilities differs from the two-step approach adopted in most of the empirical literature on currency crises[1]. Such studies first employ a crisis proxy to construct a series of zeros and ones for tranquil and speculative episodes, and then use this binary series -in a logit or probit model or other- to determine the variables that explain speculative attacks. The MSM with Time-Varying Transition Probabilities, on the other hand, identifies the episodes of speculative pressure and periods of calm simultaneously with the factors determining the switches between them.

An appealing feature of the MSM is that it provides an adequate tool to investigate the basic characteristics of second generation models. In the above mentioned optimising models, currency crises are commonly perceived as conscious decisions by policymakers who optimally choose to switch from a fixed to a floating exchange rate (or from one parity to another). Efforts to verify second generation models empirically have however been slender, mainly because they generate multiple equilibria which are

[1] *Inter alia*, Dornbush et al. (1995); Eichengreen et al. (1995, 1996); Frankel & Rose (1996), Kaminsky & Reinhart (1996); Sachs et al. (1996); Goldfjan & Valdés (1997); Kumar et al. (1998); Kaminsky et al. (1998): Berg & Patillo (1998); Esquivel & Larraín (1998); Milesi-Ferretti & Razin (1998); and Demirguc & Detragiache (1998) for banking crises.

difficult to estimate. A particular advantage of the MSM is therefore that it allows one to model time series characterised by multiple equilibria.

The proposed modelling methodology moreover offers the possibility to concentrate on one currency at a time and to single out individual explanatory variables (although multivariate analysis is not precluded). Most empirical studies of currency crises undertake multivariate and multicountry analysis that uses cross-section data -or panel-data- structures. They therefore do not distinguish the different effects that different variables may have on each currency individually. The lack of robust evidence in multi-country studies probably results from the fact that currency crises are not similar enough across countries -and over time- to allow generalisations from past experience. Single-country investigations have generally focused on the first-generation models of currency crises[2]. So, although there is no shortage of speculative attacks and each crisis seems to present unique features, second-generation models are hardly tested in the context of single-country studies[3].

Finally, the chosen methodology also allows us to address the hypothesis -directly deriving from the second generation literature- that currency crises can be lengthy, and sometimes overdue, events[4]. The aim is to test whether observed deterioration in domestic economic conditions have a dynamic effect on the degree of speculative pressure or, conversely, if shocks only (to the exogenous variables) affect the possible equilibria by triggering state changes. In that case, we are led to ask at what point the identified variables will trigger the crisis. A related empirical question is whether the explanatory variables have different effects on the level of speculative pressure. The precise hypothesis is that economic, financial and political variables affect the behaviour of market participants in a different way, depending on whether speculative pressure is high or low.

[2] These comprise, inter alia, Blanco & Garber (1986), Okter & Pazarbasioglu (1995), Goldberg (1994) and Okter & Pazarbasioglu (1997).

[3] With the exception of Jeanne (1995c, 1997), Masson (1998), Jeanne & Masson (1998) and Tronzano (1999).

[4] This specific view is that of Bensaid & Jeanne (1997).

This chapter moreover provides a detailed review of the tests employed to select the correct specifications of the model. This aspect is usually overlooked in the literature using the MSM and the present chapter argues that it is crucial to discuss the specification of the model.

The chapter is organised as follows. Section Two explains the rationale behind the use of the Markov Regime Switching to model currency crises. Section Three presents the main features of the Markov Regime Switching Model (MSM). Methodological issues are discussed in Section Four. Section Five describes several tests used in the estimation to choose the appropriate specifications for the model. The choice of the indicators of currency crises is analysed in Section Six. The indicators are classified according to whether they fall under the first -or second- generation theoretical approach.

The definition, source and transformation of the data are also given in Section Six. Section Seven concludes the chapter.

4. 2. Modelling Currency Crises as a Regime Switching Process

It has been widely argued that foreign exchange market expectations are subject to sudden movements. The European Exchange Rate Mechanism (ERM), indeed, has been characterised by long periods of relative stability interrupted by short and sharp speculative attacks. Svensson (1993), for example, shows that realignment expectations -as measured by the drift-adjustment method- can be described as constant in "normal" times, with short and sharp increases, possibly corresponding to crisis episodes[5]. The initial justification for the choice of the methodology therefore rests upon the clear observation that, in the ERM, realignment expectations and exchange market pressure did not increase gradually before currency crises but appeared to shift suddenly and at uncertain moments.

[5] This observation is also made by, *inter alia*, Caramazza (1993); Chen & Giovannini (1994) and Thomas (1994).

It is also indisputable that there have been policy regime switches during the ERM period, in terms of fiscal and monetary policies as well as with regard to the political commitment to the exchange rate system. Policymakers' priorities among the different objectives of economic policy vary. That is, the weight they attach to inflation, unemployment, and constancy of the exchange rate changes over time. Inasmuch as currency crises are the result of a conflict between domestic objectives and the currency peg, shifts in the expectations of devaluation are directly connected to shifts in policymakers' preferences. Drazen & Masson (1994), for example, argue that the credibility of the French franc varied in the 1980s according to changes in the authorities' resolve to the fixed exchange rate peg. In a dissimilar -yet related- paper, Ruge-Murcia (1995) model government expenditure in Israel after the 1984 stabilisation process as an exogenous autoregressive process subject to discrete changes in regime, with transitions determined by a Markov chain with constant probabilities. It is found that increased uncertainty about the true state of the expenditure process partially explains the volatility of inflation.

For the reasons listed above, it appears adequate to direct research towards the application of regime switching models. Furthermore, to conform to theoretical predictions, one has to link the occurrence of currency crises to economic events. First generation models state that speculative attacks are the result of bad economic performance. In an empirical paper on Speculative Attacks, Goldberg (1994) writes: "The probability of a speculative attack on central banks' foreign exchange reserves depends on agents' forecasts of a range of economic variables, including expected domestic credit growth, the systematic overvaluation of domestic goods and the potential magnitudes of internally and externally generated shocks."

Even in second generation models it is only when fundamentals are sufficiently weak that a currency is potentially vulnerable to speculative attacks. Optimising models mainly differ in their hypothesis as to which variable enters in the policymaker's objective function to determine the optimal switch point. Although second generation models raise the principal question as to whether the crises are caused by self-fulfilling speculation or by bad fundamentals, we have no intention to follow this dichotomy.

Rather, it is alleged that what matters is the symptomatic link between particular variables -economic fundamentals or political news- and the behaviour of exchange rates for each particular crisis. The objective of the study is therefore to identify the variables that cause shifts in the level of speculative pressure.

In fact, many studies suggest that the relationship between currency crises and fundamentals is not linear[6] -see Jeanne (1997); Masson (1998), Jeanne & Masson (1998) and Martinez (1999). In an investigation of the potential determinants of realignment expectations, Rose & Svensson (1994), reveal that the credibility of the ERM varies significantly over time, mostly for reasons that cannot be explained by standard macroeconomic variables in a linear context[7]. Thomas (1994), using an OLS regression, finds only very weak evidence that realignment expectations are related to macroeconomic fundamentals in a linear way. Likewise, Chen & Giovannini (1994) are unable to find any significant correlation between realignment expectations and a whole set of domestic and foreign macroeconomic fundamentals.

Various models incorporating non-linearities associated with regime switching have proved useful in macroeconomics and dynamic economics; and Hamilton's (1989) Markov Switching Model (MSM) has recently become very popular. The model has been extensively applied in the literature on business cycles[8] and unemployment persistence[9], as well as to model the behaviour of interest rates[10], exchange rates[11], stock returns[12] and, more recently, currency crises[13].

Most papers however assume that the transition probabilities are constant, which does not seem consistent with the literature. Assuming that the switch between regimes

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[6] This observation has led DeGrauwe et al. (1993) to model foreign exchange markets taking into account the heterogeneity of investors; that is, investors who base their decisions on fundamentals and those who only react to past movements in exchange rates.
[7] Rose & Svensson (1994) use a VAR model.
[8] Hamilton (1989); Filardo (1994); Diebold & Rudebusch (1996);
[9] Bianchi & Zoega (1997); Akram (1998).
[10] Regime switching has been found in the conditional mean dynamics of interest rates in Hamilton (1988), Cai (1994) and Sola & Driffill (1994).
[11] Engel & Hamilton (1990); Engel & Hakkio (1996); Van Norden (1996) indicate there are long swings in exchange rates and show that exchange rates switch from stable to unstable regimes.
[12] The conditional variance dynamics of stock returns are modelled as a MSM in Hamilton & Susmel (1994).
[13] Jeanne & Masson (1998), Tronzano (1999) and Martinez (1999).

depends only on the regime in the previous period precludes the possibility that switches between regimes should be influenced by economic fundamentals, and political news [14]. Therefore, the study will apply the Time-Varying Transition Probability (TVTP) version of the MSM as developed by Diebold, Lee & Weinbach (1994) and Filardo (1994).

In fact, Jeanne & Masson (1998) suggest further developments in the empirical investigation of currency crises and write: "To the extent that the sunspot variable instantaneously co-ordinates the expectations of all market participants, one would like to relate this variable to an event that is publicly observable. It would be interesting to see whether the transitions between states that are identified by the Markov switching technique are correlated with political events or other news." Martinez (1999) indeed finds that the application of a regime switching model with time-varying transition probabilities to speculative attacks performs better than other techniques used in the literature.

4. 3. The Markov Regime Switching Model

Considerable judgement can be involved in determining currency crisis dating. The MSM explicitly takes into account the probabilistic nature of these judgements by treating the state of the explanatory variable, as an unobserved latent variable, which follows an observed Markov process.

4. 3. 1: Fixed Transition Probabilities (FTP)

The basic idea is to model the distribution of a time series as deriving from one of two possible states 'normal' times (n) or 'crises' (c) and therefore to characterise the two regimes and the law that governs the transition between them.

[14] If the transition probabilities are fixed, periods of stability in foreign exchange markets are more likely to occur solely because the previous period was stable, and a crisis is more likely simply when the previous period is a crisis.

Let $\{y_t\}_{t=1}^{T}$ be the sample path of a time series that depends on $\{s_t\}_{t=1}^{T}$ as follows: $(y_t|s_t = i;\alpha_t) \overset{iid}{\sim} N(\mu_i,\sigma_i^2)$ such that the density of y_t, conditional on the state is:

$$f(y_t|s_t = i;\alpha_t) = \frac{1}{\sqrt{2\pi}\sigma_i}\exp\left(\frac{-(y_t-\mu_i)^2}{2\sigma_i^2}\right) \qquad \text{where } i \quad n,\ c \tag{1}$$

In other words, the behaviour of y_t is described by a mixture of two normal distributions and the parameters of the distributions are: $\alpha=(\mu_i,\sigma_i^2)$ where μ stands for the mean, σ^2 for the variance; and i=*n*, *c* denotes the normal and crisis states respectively.

The Markovian nature of the model comes from the discrete time, discrete state process assumed for the variable, where the stochastic process is characterised by the probability of moving from state *j* to state *i*, $p(s_t = i|s_{t-1} = j)$. The FTP matrix is given by:

$$\begin{bmatrix} p_{nn} & 1-p_{nn} \\ 1-p_{cc} & p_{cc} \end{bmatrix} \tag{2}$$

where p_{nn} and p_{cc} are the probabilities of staying in states *n* and *c*, respectively.

States *n* and *c* may be differentiated not only by their means but also by their variances. There can be asymmetries in the persistence of the regimes, e.g. periods of high speculative pressure could be short (p_{cc} small), whilst normal times of could be gradual and prolonged (p_{nn} large)[15].

Following Engle & Hakkio (1996) and Filardo (1994), the transition probabilities are modelled by the logistic family of functional forms. Specifically,

$$p_{nn} = \frac{e^{\delta_n}}{1+e^{\delta_n}} \ and \ p_{cc} = \frac{e^{\delta_c}}{1+e^{\delta_c}} \tag{3}$$

[15] Looking back to the history of the EMS, speculative runs were not very important in the earliest phases of the EMS when realignment were small and frequent. Indeed, three crises only are typically cited as driven mainly by speculative pressure: January 1987; September and November 1992 and the summer of 1993.

The draws of y_t in this model are not independent. The inferred probability that a particular observation comes from the 'normal' or 'crisis' distribution depends on the realisation of y at other times. More precisely, the process for S_t is presumed to depend on past realisations of Y_t and S_t only through S_{t-1}.

In other words, the probability law for the dependent variable is summarised the following vector of parameters: $\theta = (\mu_t, \sigma_i^2, \delta_i^0, \delta_i^1)'$

These parameters are thus sufficient to describe:
(i) the distribution of Y_t given S_t
(ii) the distribution of S_t given S_{t-1} as in equation (3)
(iii) the unconditional distribution of the state of the first observation:

$$p(s_1 = n;\theta) \equiv \rho = \frac{(1-p_{cc})}{(1-p_{nn})+(1-p_{cc})} \quad (4)$$

[16]

Of course, $p(s_1 = c;\theta) = 1-\rho$.

The complete data likelihood[17] for the sample of size T, $Y_T = (y_1,...,y_T)$, along with the unobserved states $S_T = (s_1,....,s_T)$ is then:

$$\begin{aligned} f(y_1,...,y_T,s_1,...,s_T;\theta) &= f(y_T|\ s_T;\theta).p(s_T|\ s_{T-1};\theta). \\ &f(y_{T-1}|\ s_{T-1};\theta).p(s_{T-1}|\ s_{T-2};\theta)....p(s_2|\ s_1;\theta).f(y_1|\ s_1;\theta).p(s_1;\theta) \end{aligned} \quad (5)$$

Obviously, the complete data log likelihood cannot be constructed because the complete data are not observed. However, the fact that the states are unobserved is, in theory, inconsequential, because the incomplete data log-likelihood may be obtained by summing over all possible state sequences, $(s_1,.....,s_T)$:

$$f(y_1,....,y_T;\theta) = \sum_{s_1=n}^{c} \cdots \sum_{s_T=n}^{c} f(y_1,...,y_T,s_1,...,s_T;\theta) \quad (6)$$

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[16] The value of ρ is later used for the starting values of the unconditional probabilities in period one.
[17] "Complete data" refers to the hypothetical case where both $\{y_t\}$ and $\{s_t\}$ are observed.

4. 3. 2: Time-Varying Transition Probabilities (TVTP)

As mentioned above, it is highly restrictive to require constancy of the transition probabilities. Rather, they should be allowed to vary with economic, financial and political variables. Therefore, our further aim is to extend Hamilton's (1989) MSM to allow exogenous time series to influence the regime switching probabilities.

The implicit assumption is that the TVTP model can provide valuable additional information about whether a particular phase has occurred and whether a turning point is imminent. For example, suppose the foreign exchange market is in a crisis state and the domestic unemployment is high. The time-varying transition probability model would allow the probability of staying in the crisis state to be greater in this case (than if domestic unemployment was low).

So, where it was implicitly assumed, above, that the transition probabilities were constant, we now let $p_{nn} = p_{nn}(Z_t)$ and $p_{cc} = p_{cc}(Z_t)$; with Z representing the value of the relevant 'trigger' variables, with history: $Z_T = \{z_T, z_{T-1}, \ldots, z_0\}$

The Markov process on the states then becomes:

$$p(S_t = s_t \mid S_{t-1} = s_{t-1}; Z_t) = \begin{bmatrix} p_{nn}(Z_t) & 1-p_{nn}(Z_t) \\ 1-p_{cc}(Z_t) & p_{cc}(Z_t) \end{bmatrix} \tag{7}$$

Again, logistic functions are chosen for the transition probabilities that map the explanatory variable into the unit interval. More precisely:

$$p_{nn}(Z_t) = \frac{e^{\delta_n^0 + \delta_n^1 z_t}}{1 + e^{\delta_n^0 + \delta_n^1 z_t}} \quad and \quad p_{cc}(Z_t) = \frac{e^{\delta_c^0 + \delta_c^1 z_t}}{1 + e^{\delta_c^0 + \delta_c^1 z_t}} \tag{8}$$

The type of 'news' contained in the z variables can be inferred from the signs of the parameters characterising the transition probability. If δ_i^1 is positive, then $(\partial p_{ii} / \partial z) > 0$ which means that the probability of staying in state i *-n* or *c-* is greater the larger z_t -since the sign of $(\partial p_{ii} / \partial z)$ is the same that of (δ_i^1). For example, if δ_n^1

is positive a normal state is more likely to be followed by a normal state when the explanatory variable is positive in a given month. Inversely, if δ_n^1 is negative, then the probability of staying in the normal state is greater the smaller z_t.

The complete data likelihood is then:

$$f(Y_T,S_T|\ Z_T;\theta)=f(y_1,s_1|\ z_{t-1};\theta)\prod_{t=2}^{T}f(y_t,s_t|\ y_{t-1},s_{t-1},z_{t-1};\theta)$$

$$=f(y_1|\ s_1,z_{t-1};\theta)P(s_1)\prod_{t=2}^{T}f(y_t|\ s_t,y_{t-1},s_{t-1},z_{t-1};\theta)P(s_t|\ y_{t-1},s_{t-1},z_{t-1};\theta) \qquad (9)$$

$$=f(y_1|\ s_1;\alpha)P(s_1)\prod_{t-2}^{T}f(y_t|\ s_t;\alpha)P(s_t|\ s_{t-1},z_{t-1};\delta)$$

Summing over all possible state sequences gives:

$$\log f(Y_T|\ Z_T;\theta)=\log(\sum_{s_1=n}^{c}\ \sum_{s_2=n}^{c}\ \ldots\sum_{s_T=n}^{c}f(Y_T,S_T|\ Z_T;\theta) \qquad (10)$$

4. 4. Methodological Issues

Although Hamilton (1990) and Diebold, Lee & Weinbach (1994) successfully employ the EM algorithm, in this specific study, the Maximum Likelihood (ML) method is first selected on the grounds of its computational simplicity. The parameters of interest are jointly estimated by maximising the log-likelihood function numerically[18]. Construction and numerical maximisation of the incomplete data log likelihood as in equation (10) is computationally intractable, as it requires 2^T summations.

In practice, most applications use Hamilton's (1989) simpler algorithm for evaluation of equation (10), whereby the parameter estimates are used to infer the unobserved states at any historical date, on the basis of information at the time: $p(s_t|\ y_1,\ldots,y_t;Z_t,\theta)$.

[18] All programmes were written in GAUSS. The likelihood function is maximised numerically using the secant algorithm of Broyden, Fletcher, Goldfarb and Shanno (BFGS) provided by the optimisation package of GAUSS.

This probability is commonly referred to as the 'filter' inference about the probable regime at date t[19].

4. 4. 1. Filtering

The input for the basic filter is the previous period joint-conditional-probability; that is: $p(s_{t-1} = i, s_{t-2} = j \mid Y_{t-1}, Z_{t-1})$ and the output is the current period joint-conditional-probability, $p(s_t = i, s_{t-1} = j \mid Y_t, Z_t)$, along with the conditional likelihood of y, $f(y_t \mid Y_{t-1}, Z_t)$.

Step 1 is the calculation of:

$$p(s_t = i, s_{t-1} = j \mid Y_{t-1}, Z_t; \hat{\theta}) = p(s_t = i \mid s_{t-1} = i, Z_t; \hat{\theta}).p(s_{t-1} = i \mid Y_{t-1}, Z_{t-1}; \hat{\theta})$$

where $p(s_t = i \mid s_{t-1} = j, Z_t; \hat{\theta})$ is given by equation (8) -respectively, equation (3) for the FTP model.

Step 2 is the calculation of the joint conditional density-distribution of y_t *and* s_t:

$$f(y_t, s_t = i, s_{t-1} = j \mid Y_{t-1}, Z_{t-1}; \hat{\theta}) = f(y_t \mid s_t = i; \hat{\alpha}).p(s_t = i, s_{t-1} = i \mid Y_{t-1}, Z_{t-1}; \hat{\theta}),$$

where

$$f(y_t \mid s_t = i; \hat{\alpha}) = \frac{1}{\sqrt{2\pi}\sigma_t} \exp\left[-\frac{1}{2\sigma_i^2}(y_t - \mu_{it})^2 \right].$$

In Step 3, we get:

$$f(y_t \mid Y_{t-1}, Z_{t-1}; \hat{\theta}) = \sum_{i=n}^{c} \ldots \sum_{i=n}^{c} f(y_t, s_t = i, s_{t-1} = j \mid Y_{t-1}, Z_{t-1}; \hat{\theta})$$

Next, Step 4 provides:

$$p(s_t = i, s_{t-1} = j \mid Y_t, Z_t; \hat{\theta}) = \frac{f(y_t, s_t = i, s_{t-1} = j \mid Y_{t-1}, Z_{t-1}; \hat{\theta})}{f(y_t \mid Y_{t-1}, Z_{t-1}; \hat{\theta})}$$

[19] The approach is akin to the Kalman filter technique and is merely a Bayesian updating formula.

Step 5, finally, gives the desired output as thus:

$$p(s_t = i|\ Y_t, Z_t; \hat{\theta}) = \sum_{i=n}^{c} p(s_t = i, s_{t-1} = j|\ Y_t, Z_t; \hat{\theta})$$

4. 4. 2. Smoothing

The full sample of *ex post* available information $Y_T = (y_1, ..., y_T)$ may also be used to draw an inference about the historical state the process was in at some date t: $p(s_t|\ Y_T, Z_T; \theta)$ which is referred to as the smoothed inference about the regime at date t.

Kim (1994) provides us with a method to estimate the smoothed probabilities based upon the fact that, for the last observation, the smoothed and filtered probabilities are equal $p(s_T|\ Y_T, Z_T; \theta)^s = p(s_T|\ Y_T, Z_T; \theta)^f$. One can then use a recursive formula for the smoothed probabilities.

4. 5. Specification Tests

4. 5. 1. Comparative Tests

The comparison of the models is based on several different criteria. These include the conventional Schwarz criterion, mean squared error and a measure of the success of each model in identifying turning points.

The Schwarz information criterion (SC) is commonly used as a guide to the selection of the number of terms in an equation. It places penalty on extra coefficients. The Schwarz model selection criterion is calculated as: *SC–L-(a 2).ln(T)*, for L the maximum value of the log-likelihood function and a the number of freely estimated parameters[20], and T the sample size. The rule is to choose the specification with the highest value of the SC.

The usefulness of each model in identifying turning points is evaluated as the fraction of the time that the model correctly anticipates which phase the dependent variable is in. The model generates the implicit identification of turning points in the form of conditional probability that the unobserved variable s_t is in regime c: $\hat{d}_t = prob\{s_t = c | \; y_{t-1}, y_{t-2}, ..., y_1\}$.

The "Turning Point" statistic (TP) is therefore based on the mean squared deviation from the ex-post record of crisis periods, d_t, presented in Tables 2 and 10 in Chapter 5. That is, d_t=1 if date t was part of a currency crisis or realignment, and d_t=0 otherwise: $TP = T^{-1}\sum_{t=1}^{T}(d_t - \hat{d}_t)^2$. A standard of comparison is to calculate a benchmark $\overline{TP}$ that is constant and equal to the historical fraction of crisis periods (months); i.e. $\overline{TP} = T^{-1}\sum_{t=1}^{T} d_t$. The model will be successful with respect to its identification of in-sample turning points inasmuch as the estimated statistic, TP, is smaller than the benchmark.

Another indicator that helps choosing the adequate model is a comparison of the in-sample mean squared error: $MSE = (T-1)^{-1}\sum(y_1 - \hat{y}_{t-1})^2$.

4. 5. 2. Specification Tests

Most papers on the Markov Switching model do not attempt to test the null hypothesis of one state against the alternative of two states because the standard asymptotic

[20] The constant term involving 2π has been omitted from all calculations.

distribution theory does not hold for this case[21]. The statistical problem is that the transition probabilities p_{nn} and p_{cc} are unidentified under the null hypothesis that μ_n μ_c . i.e. p_{nn} and p_{cc} do not converge in probability to any fixed population parameters and, moreover, the score with respect to the parameters of interest in the alternative may identically be equal to zero under the null[22]. Hansen (1992) also points out that, in either event, the information matrix is singular and thus proposes a bounds test that is valid despite this problem.

Given the difficulty in implementing Hansen's approach computationally[23], general tests for possible misspecification based on Hamilton (1990, 1996) are presented for the static mean-variance model with fixed transition probabilities. In fact, there are no theoretical econometrics for specification testing when transition probabilities are time-varying. Having said that, the purpose of the tests is to determine the correct model to capture the dynamics of the time series and it is believed that the extension of the MSM to time-varying probabilities does not alter the conclusions of the tests.

Hamilton (1989, 1990, 1996) shows how White's (1987) results may be used to construct a set of specification tests -for static models with fixed transition probabilities- based on the serial correlation properties of the gradient vectors for a given set of parameter estimates. Simple tests for serial correlation, ARCH, and Markov switching[24] are therefore built by considering the score with respect to the mean, the variances and the transition probabilities, respectively.

Let θ denote the $(a\times1)$ vector of population parameters. The hypothesis that the score statistics are serially uncorrelated is tested on the basis of White (1987) where the score $h_t(\theta)$ is defined as the $(a\times1)$ vector whose i-th element is the derivative of the conditional log-likelihood of the t-th observation with respect to the i-th element of the parameter vector θ.

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[21] The other two classical tests, the Lagrange multiplier and Wald tests share the same property.
[22] They are then nuisance parameters whose values do not affect the value of the likelihood function.
[23] Besides, Hansen's test only provides a bound on the asymptotic distribution of the standardised LR test, and the test is conservative, tending to be under-sized in practice and of low power.
[24] That is, a test of the assumption that the unobserved regime s_t follows a first-order Markov process.

$$h_t(\theta) = \frac{\partial \log f(y_t|\ y_{t-1}, y_{t-2},...,y_1;\theta)}{\partial \theta} \tag{11}$$

For example if the model is correctly specified, the scalar $c_{ij,t}(\theta)$ which denotes the product of the i-th element of $h_t(\theta)$ with the j-th element of $h_{t-1}(\theta)$, should be zero:

$$E[c_{ij,t}(\theta)]\ \ 0 \tag{12}$$

White (1987)[25] suggests compiling the a elements of $c_{ij,t}(\theta)$ that are important into an $(a_0 \times 1)$ vector $c_t(\theta)$ and calculating the statistic:

$$H_T = a_0^{-1}\left[T^{-1}\ {}^2\sum c_t(\hat{\theta})\right]\hat{A}^{22}\left[T^{-1}\ {}^2\sum c_t(\hat{\theta})\right] \tag{13}$$

Where $\hat{A}^{22}$ denotes the (2,2) subblock of the inverse of the following partitioned matrix:

$$(T-a)^{-1}\begin{bmatrix} \sum_{t-1}^{T}[h_t(\hat{\theta})][h_t(\hat{\theta})]' & \sum_{t=1}^{T}[h_t(\hat{\theta})][c_t(\hat{\theta})]' \\ \sum_{t-1}^{T}[c_t(\hat{\theta})][h_t(\hat{\theta})]' & \sum_{t-1}^{T}[c_t(\hat{\theta})][c_t(\hat{\theta})]' \end{bmatrix} \tag{14}$$

Then, if the model is correctly specified: $a_0\, H_T \rightarrow \chi^2(a_0)$.

Hamilton (1996) suggests that three elements of $c_{ij,t}(\theta)$ are of particular interest. That is, one can test for omitted serial correlation when i in (12) is the derivative of $\log(y_t|\ y_{t-1}, y_{t-2},..., y_{-p+1};\theta)$ with respect to μ_c or μ_n and j relates to the derivative of $\log(y_{t-1}|\ y_{t-2},..., y_{-p+1};\theta)$ with respect to μ_c or μ_n. Similarly, one can test for omitted autoregressive conditional heteroskedasticity when i in (12) is the derivative of $\log(y_t|\ y_{t-1}, y_{t-2},..., y_{-p+1};\theta)$ with respect to σ_c or σ_n and j is the derivative of

$\log(y_{t-1}|\ y_{t-2},...,y_{-p+1};\theta)$ with respect to the same elements. Finally, to test the assumption that the state follows a first order Markov chain, i in (12) corresponds the derivative of $\log(y_t|\ y_{t-1},y_{t-2},...,y_{-p+1};\theta)$ with respect to p_{cc} or p_{nn} and j is the derivative of $\log(y_{t-1}|\ y_{t-2},...,y_{-p+1};\theta)$ again with respect to the same elements, or with respect to the means.

Note that the recommended small-sample procedure to implement the White tests for specification is to multiply the computed statistic by $(T\text{-}a)/(T.a_0)$ and compare the resulting statistic with an $F(a_0, T\text{-}a)$ distribution. The latter statistic will have the same asymptotic properties but better small-sample performance than the unadjusted statistic.

Lagrange Multiplier (LM) tests are also performed for various dynamic misspecification tests. Suppose the $(a\times 1)$ parameter vector θ is estimated subject to the constraint that the last a_0 elements are zero. At the constrained MLE $\hat{\theta}$, the first $(a\text{-}a_0)$ elements of the average score are zero (due to the first order conditions for constrained maximisation of the likelihood function), whilst the last a_0 are non-zero. Then the magnitude of these last a_0 elements measures by how much the likelihood function could increase if the constraints were relaxed; and as such allow to assess the validity of the constraints. Asymptotically:

$$\left[T^{-1/2}\sum_{t=1}^{T}h_t(\tilde{\theta})\right]'\left[(1/T)\sum_{t=1}^{T}[h_t(\tilde{\theta})][h_t(\tilde{\theta})]'\right]^{-1}\left[T^{-1/2}\sum_{t=1}^{T}h_t(\tilde{\theta})\right]\xrightarrow[d]{}\chi^2(a_0)$$

The assumption of no serial correlation is tested against the alternative of omitted autocorrelation in state n only, in state c only and across regimes. Similarly, the assumption of no ARCH effect is tested against the alternative of heteroskedasticity.

Asymptotic LM tests with better small-sample performance are obtained by multiplying the computed test values by $(T\text{-}a\text{+}a_0)/(T.a_0)$ and comparing the results with

[25] White (1987) describes tests for serial correlation of the scores using the conditional moment tests of Tauchen

an F(a_0, T-a+a_0) distribution; where a is the total number of parameters and a_0 is the number of restrictions.

Because Hamilton (1990, 1996) only describes tests applicable to the static MSM with fixed transition probabilities, Box-Pierce Q-statistics are calculated in models with dynamic specifications. If the model is correctly specified, the autocorrelations between the disturbances in period t and the disturbances in k periods previous, $\hat{\rho}_k$, should be uncorrelated, normally distributed random variables with mean zero and variance $1 T$, where T is the number of observations in the time series.

The Box-Pierce Q-statistic tests the joint hypothesis that all the autocorrelation coefficients for the residuals are zero; i.e. $\hat{\rho}_k = 0$ for all k. The Q-statistic is the sum of the squared correlation coefficients and has an approximate χ^2 distribution with m degrees of freedom (m being the number of residual autocorrelation we wish to consider); i.e. $Q(m) = T\sum_{k=1}^{m} \hat{\rho}_k^2 \sim \chi^2(m)$.

Therefore, if the calculated value of $Q(m)$ is greater than the critical 5 percent level , there is a 95 percent chance that the true autocorrelation coefficients are not all zero. Likewise to test for heteroskedasticity of the residuals, the Q-statistic can be calculated to test the joint hypothesis that all the standardised residual correlations (i.e. the residual autocorrelations multiplied by the residual variance, $\hat{\rho}_k / T$) are zero[26].

Furthermore, Andrews' (1993) test for parameter stability is used to test whether there is a permanent break in the mean of the series for all possible change point in the sample. The statistic is an LM test of the null that the data are correctly modelled by the Markov-switching model against the alternative that there is a further change in the mean of the process at each date that is not captured by the estimated model.

(1985).

[26] The GAUSS program to calculate the Box-Pierce Q-Statistics was kindly provided my M. Sola. The programmes to run the specification tests (White, LM and Andrews) were provided by J.Hamilton.

Andrews (1993) suggests that the maximum LM test statistic has an asymptotic distribution that for any given break point is approximately $\chi^2(1)$ (corresponding to $p=1$ in Andrews' Table 1). The test is calculated for any break point in the sample omitting the first 15% and last 15% of the sample size (corresponding to π_0 = 15 in Andrews' table 1).

4. 6. Indicators of Currency Crises

The explanatory variables used in the analysis are defined and explained below. Because the objective is not only to explain currency crises but also to evaluate the explanatory power of the chosen model in-sample, the study introduces current variables to test for simultaneous effect, and lagged variables to test for possible indications of imminent crisis.

The variables most associated with the first generation models of currency crises are as follows.

Economic Fundamentals

DEBT/GDP **(DEBT)**

To the extent that excessive money creation may result from the need to finance the public sector, measures of fiscal imbalances could help survey currency crises. The DEBT/GDP ratio is henceforth assumed to provide an approximate of the fiscal position and capture the credit risk component. Insofar as the authorities are concerned about the fiscal consequences of the exchange rate peg (i.e. the effects of high domestic interest rates) in second-generation models, the decision to devalue may depend on the stock of public debt. Finally, this indicator was successfully used in a few previous empirical studies[27]. The ratio DEBT/GDP is expected to be positively associated with a crisis.

[27] Dornbusch et al. (1995); Thomas (1994).

Real Exchange Rate Misalignment **(ΔRER)**

Extensions of Krugman's basic model predict that a real overvaluation of the domestic currency, a deterioration of the trade balance and high inflation should all precede a crisis. In these papers[28] the expansionary fiscal and credit policies lead to higher demand for non-traded goods (leading to higher prices for these goods and a real appreciation of the currency) and traded goods (hence a deterioration of the trade balance). Indeed, a number of empirical studies have found that changes in a country's competitiveness usually precede a currency crisis[29]. The present study uses the percentage deviation of the real exchange rate from its average over the sample average[30]. The RER misalignment variable is defined so that its increase corresponds to a loss in competitiveness. An increase in the variable is therefore expected to increase the likelihood of a crisis.

Trade Balance **(TB)**

As mentioned above, a deterioration of the trade balance should precede a speculative attack along with a loss in competitiveness. Moreover, a measure of trade balance may add some insights since the RER variable may not be an exact measure of a country's competitiveness[31]. Trade balance was also used as an indicator of currency crises in other studies[32]. The trade balance measure is the natural log of the ratio of exports over imports. A worsening of the trade balance (a decrease in the variable) is expected to be associated with a higher probability of a crisis.

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[28] See Agenor et al. (1992) and Blackburn & Sola (1993) for a review of this literature.

[29] Caramazza (1993); Frankel & Rose (1996); Ozkan (1996), Jeanne (1997); Kaminsky et al. (1998); Sachs et al. (1998); Jeanne & Masson (1998); and Martinez (1999).

[30] There is no general measure of overvaluation. Most studies adopt cumulative deviations from the moving average, deviations form a simple time trend; deviations from fundamental equilibrium (obtained by regressing the RER on productivity, government spending, terms of trade and openness) or simply use the RER index.

[31] Both the current account or trade deficit are measures of competitiveness. The current account deficit is an estimate of excess formation of domestic capital (private and public) over national saving (private and public) and therefore reflects households', firms' and governments' intertemporal choices. These intertemporal choices are only very indirectly related to competitiveness or any other consideration relevant to international trade. In this sense, there is no simple and unambiguous relationship between the trade balance (or the current account) and measures of competitiveness such as the real exchange rate and the two variables ought to be used in the estimation.

[32] Namely, *inter alia*, Rose & Svensson (1994), Dornbusch et al. (1995); Ozkan (1996); Jeanne (1997); Kaminsky et al. (1998); Jeanne & Masson (1998), Martinez (1999).

Inflation (ΔINF)

Inflation is included to capture the idea that the expansionary monetary policy of a government is a key factor explaining balance of payment crises. Inflation may denote macroeconomic mismanagement and therefore affect the economy through various channels. Indeed, the importance of inflation in explaining devaluation expectations and currency crises has already been extensively tested[33]. The variable is the change in the inflation rate from one month to the other. The variable should have a positive effect on the likelihood of a crisis.

Financial Variables

M2/Reserves (M2 /R)

In previous studies, Frankel & Rose (1996), Eichengreen et al. (1996) and Kaminsky et al. (1998) find evidence that currency crises are usually preceded by a substantial loss of reserves and even if reserves are not crucial in second-generation models, the authorities usually make use of them to fend off attacks. Although excessively low reserves is recognised as the most universal sign of an approaching crisis, the problem remains as to what constitutes an adequate level of reserves. In principle, the relevant comparator should be the level of liabilities that implies claims of reserves. The level of liquid money (e.g. M2) is a natural measure of the potential demand for foreign assets from domestic sources. Indeed, Calvo (1996b) finds that the ratio of M2 over reserves provides a good signal of a currency's vulnerability to first generation types of crisis in which capital outflows are a cause of currency crises. Other studies use months of imports covered by reserves, but the ratio of reserves to a liquid monetary aggregate has more commonly been used in recent work[34]. The variable is the natural log of the ratio and it is expected to have a positive relationship with crises.

In the context of the second-generation models of crisis the explanatory variables may include, a priori, any macroeconomic variable that should influence the temptation of

[33] Caramazza (1993); Rose & Svensson (1994); Thomas (1994); Okter & Pazarbasioglu (1995); Dornbusch et al. (1995); Ozkan (1996); Kaminsky et al. (1998).

the government to relinquish the fixed peg. The following variables are chosen on the basis of the various theoretical contributions to the second-generation approach and under a data availability constraint[35].

Macroeconomic Fundamentals

Output Growth **(ΔIP and ΔGDP)**

Various second-generation models, based on the Barro-Gordon (1983) framework of monetary policy games, describe the monetary authorities' main objective as price stability, to be achieved via exchange rate targeting in the ERM. However, the government or central bank also has other objectives, such as output growth and unemployment Typically, a slow output growth rate is assumed to increase the incentives to switch to a more expansionary policy via an exit from a fixed peg. In Ozkan & Sutherland (1995) the cost of the fixed peg comes from the deviations of output from a certain target level. Consequently, a positive output growth rate should reduce the probability of a crisis.

Besides, output growth is also a potential indicator of first generation types of currency crises. If a country is having low growth, a hike in short-term interest rates to stop capital outflows - a typical feature of first generation models - will not be sustainable. Two variables are employed in the analysis, the change in an index of Industrial Production - as in Rose & Svensson (1994); Ozkan (1996) and Chen & Giovannini (1994)- and GDP growth - as in, *inter alia*, Kaminsky et al. (1998); Dornbusch et al. (1995).

Unemployment **(ΔUR)**

Similarly but in yet another archetype, a government is tempted to devalue so as to create an inflationary surprise, reduce unemployment and stimulate aggregate demand. High unemployment raises the cost of staying in the fixed-rate system and, in turn,

[34] The ratio of M2 to reserves is used in, *inter alia*, Sachs et al. (1996), Demirguc-Kunt & Detragiache (1998), and Esquivel & Larraín (1998).
[35] For example, variables like current account deficits are available on annual basis only.

raises devaluation expectations. Hence, it becomes even more desirable, if not inevitable, for a government to devalue the domestic currency.

The role of the unemployment rate in the determination of exchange market expectations is tested in other papers; *inter alia*, Caramazza (1993), Thomas (1994); Jeanne (1997); Jeanne & Masson (1998) and Martinez (1999). Note that, unemployment may also be an indicator for Krugman-type of currency crisis for the same reason as output growth is. The variable used is the annualised change in the unemployment rate and it is expected to be positively related to episodes of speculative pressure.

External variables

The Mark/Dollar Exchange Rate **(ΔDM$)**

Andersen (1994) suggests an additional typical factor inducing the cost of a fixed, or managed, peg to become higher than the benefits; that is the depreciation of another currency (within the ERM or not). Notably, the depreciation of the dollar against the German mark is often cited as an important factor provoking pressure in the ERM as was clearly the case in the realm of the 1992 crisis[36]. One reason is that investors typically tend to reallocate their portfolios towards German assets when the dollar depreciates, thus leading to pressure in the ERM, as was clearly the case in the mayhem of the 1992 crisis. Another relates to a contagious effect that Masson (1998) refers to as a "monsoonal" effect, which is a common external cause, i.e. a dollar depreciation, rendering several currencies vulnerable to speculative attacks. Buiter et al. (1996) for instance point out that many accounts of the 1992 crisis considered it as a dollar crisis due to the dollar depreciation, low US interest rates and the overall weakness of the American economy. The variable is the DM depreciation rate against the dollar and an increase in its value (i.e. an appreciation of the dollar) is expected to be negatively related to the probability of a crisis.

[36] The dollar fell to a historic low against the DM on September 2, 1992. See Giavazzi & Giovannini (1989) and Svensson (1994) for discussion of the correlation between tension in ERM and a weak dollar. See also Ozkan (1996) for another empirical application.

4. 7. Conclusions

This chapter has suggested that the MSM with Time-Varying Transition Probabilities is an appropriate methodology to model currency crises. The characteristics of the MSM were reviewed in detail. The chapter also described various tests to be employed when specifying the model.

The choice of indicators of currency crises was discussed and 15 indicators were selected that were relevant either theoretically or empirically. This proved to be an intricate task in the sense that there is no consensus as to what set of indicators should be extracted from the existing literature. In effect, the selection was typically subject to data availability.

It is important to point out that the proposed method is not free from flaws. It would clearly be incorrect for example to interpret the application of the modelling methodology in a "structural" way since many of the explanatory variables are endogenous. It is equally crucial to note that the method is not a literal estimation of any given model and that the reasons for the multiplicity of equilibria are not explicitly justified.

APPENDIX 4. 1.

French Indicators of Currency Crisis

Figure F1: DEBT

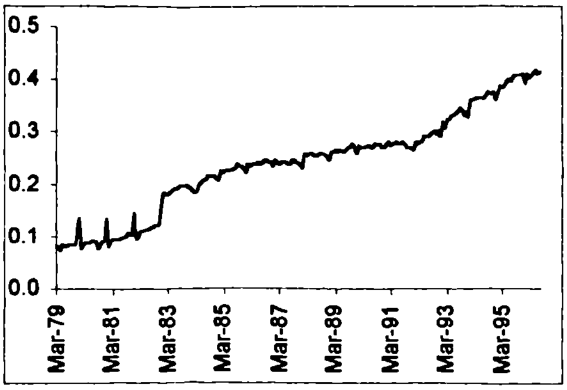


Figure F2: ΔINF

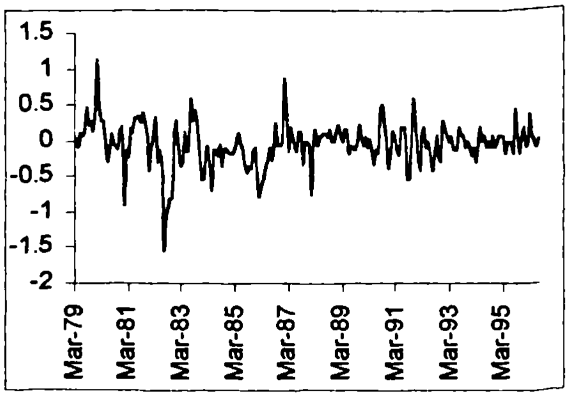


Figure F3: ΔIP

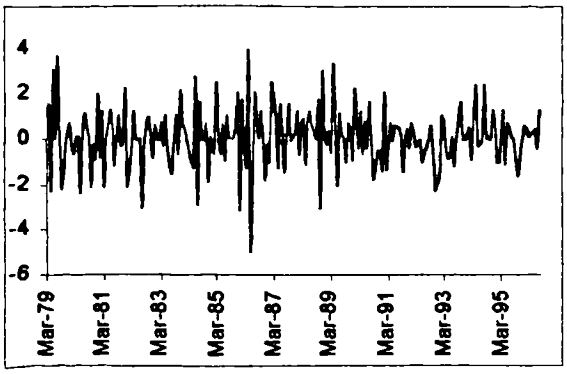


Figure F4: ΔRER

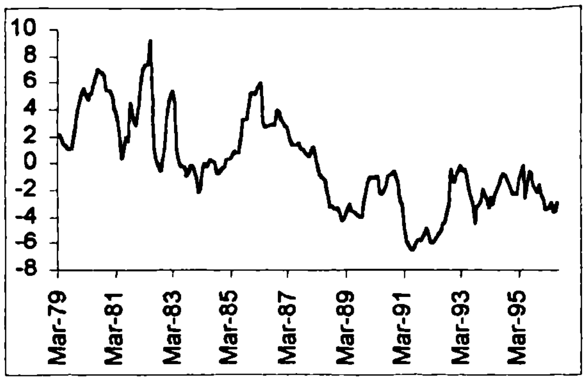


Figure F5: TB

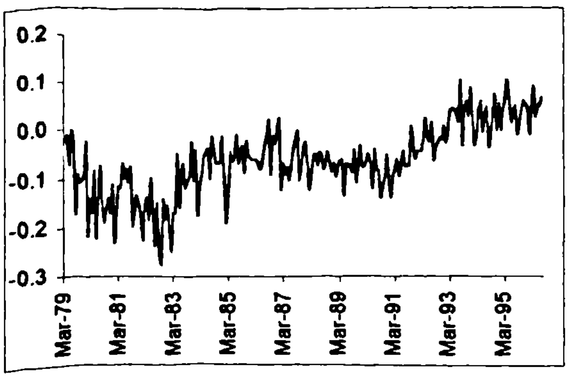


Figure F6: M2/R

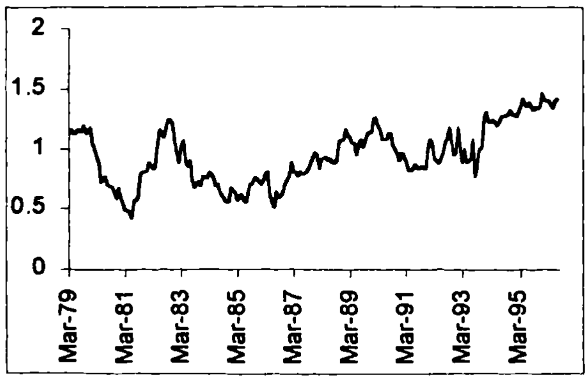


Figure F7: ΔUR

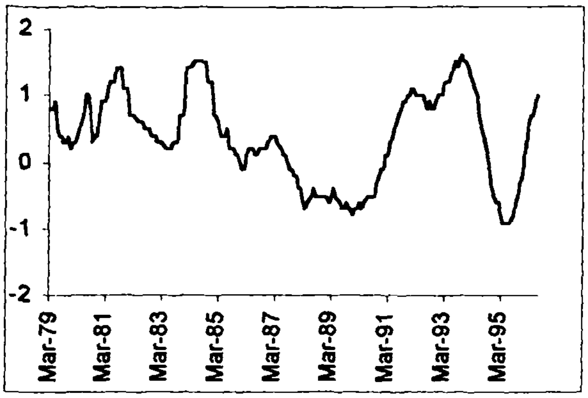


Figure F8: ΔGDP

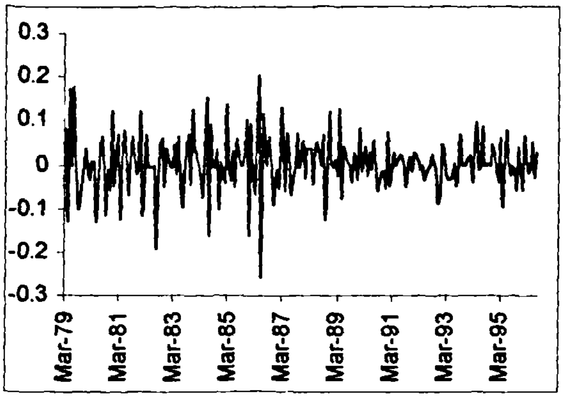


Figure F9: ΔDM$

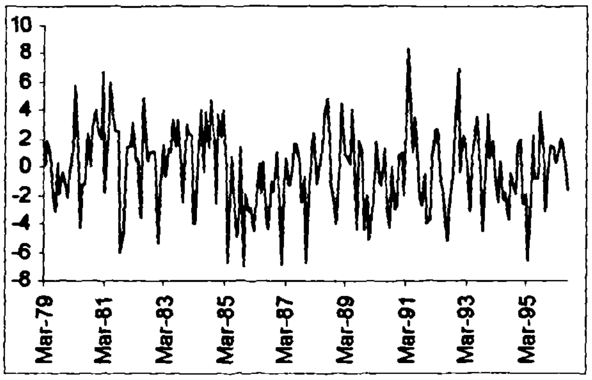


Figure F10: DEBTD

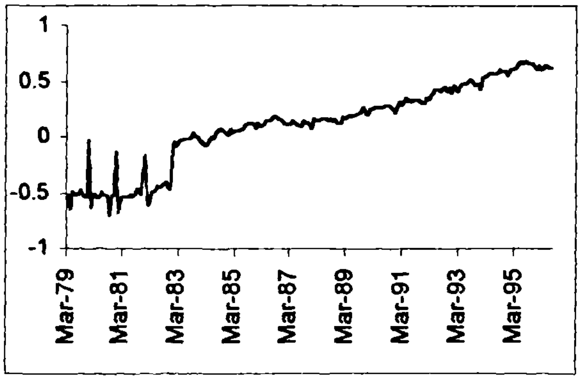


Figure F11: ΔINFD

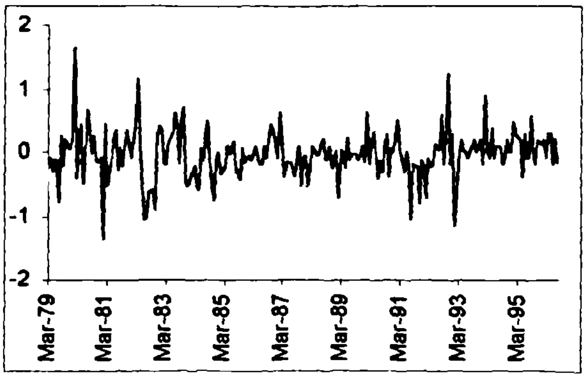


Figure F12: IPD

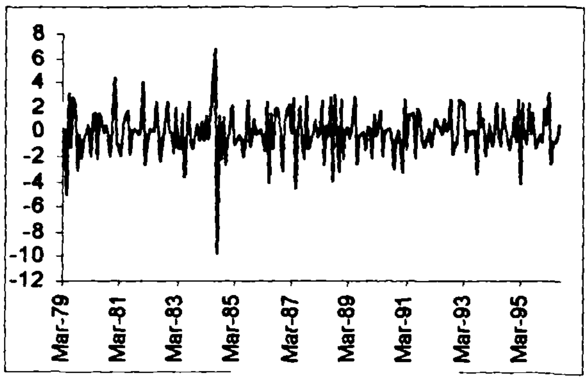


Figure F13: ΔRERD

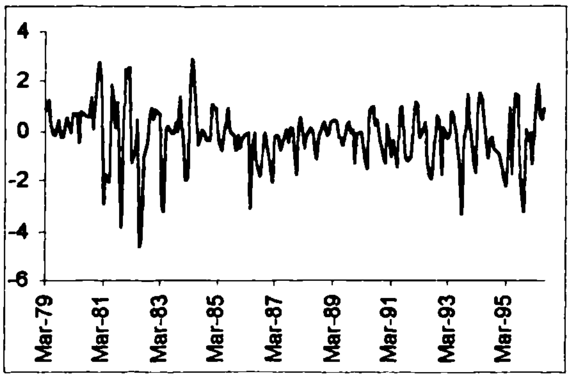


Figure F14: ΔTBD

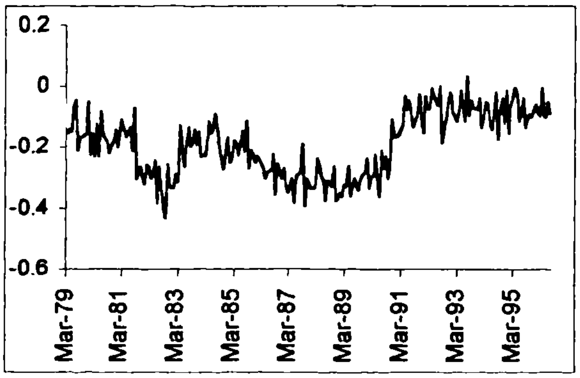


Figure F15: M2/RD

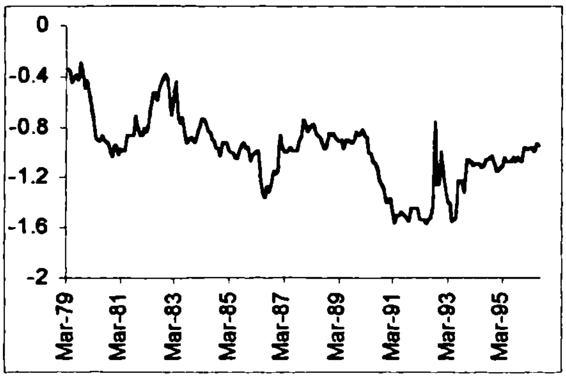


Figure F16: ΔURD

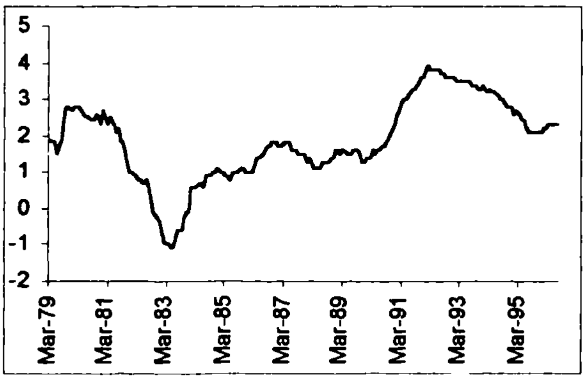
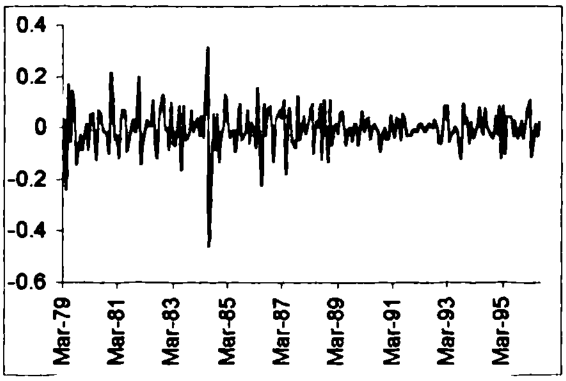


Figure F17: ΔGDPD



APPENDIX 4. 2.

Italian Indicators of Currency Crisis

Figure I1: DEBT

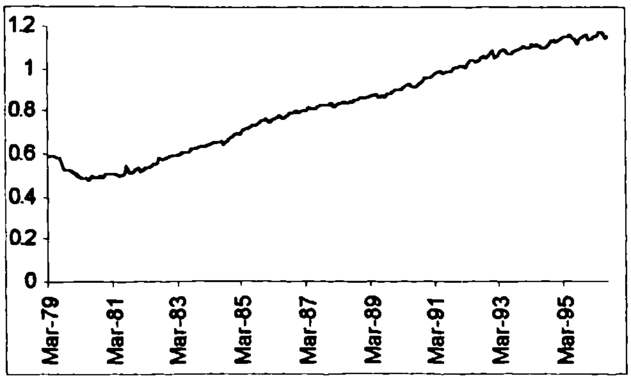


Figure I2: ΔINF

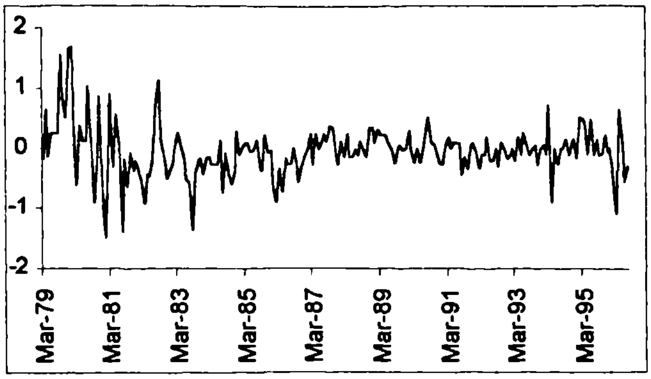


Figure I3: ΔIP

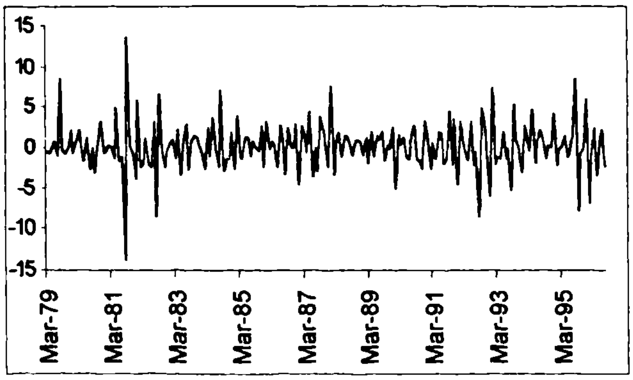


Figure I4: ΔRER

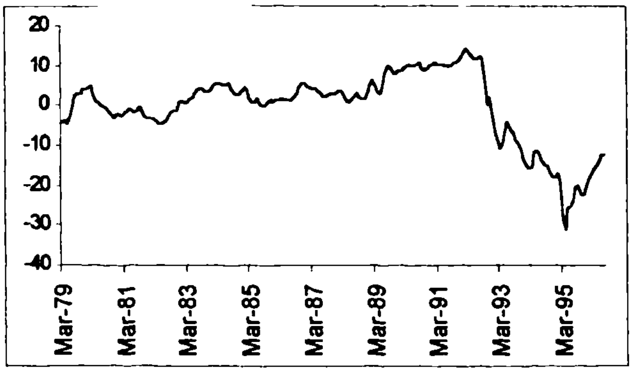


Figure I5: TB

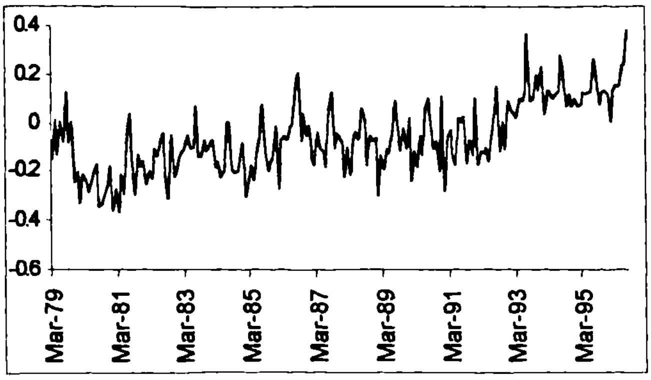


Figure I6: M2/R

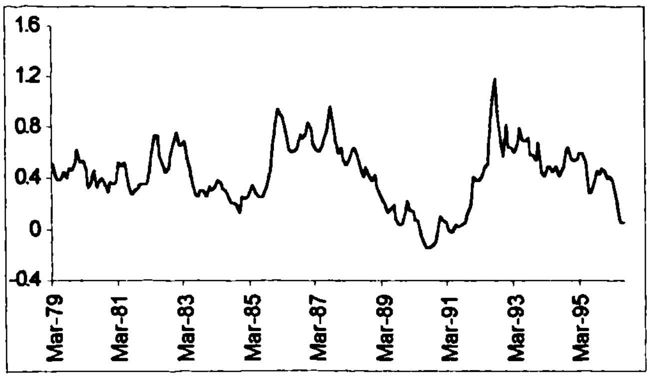


Figure I7: ΔGDP

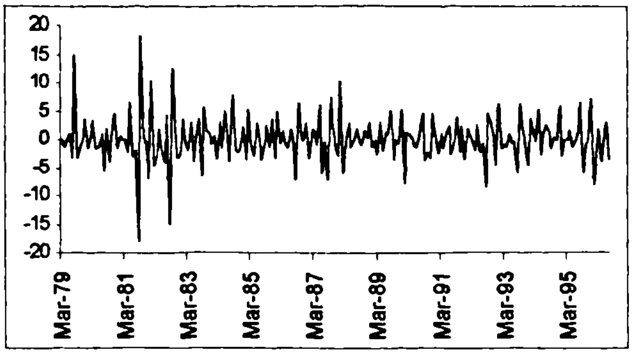


Figure I8: DEBTD

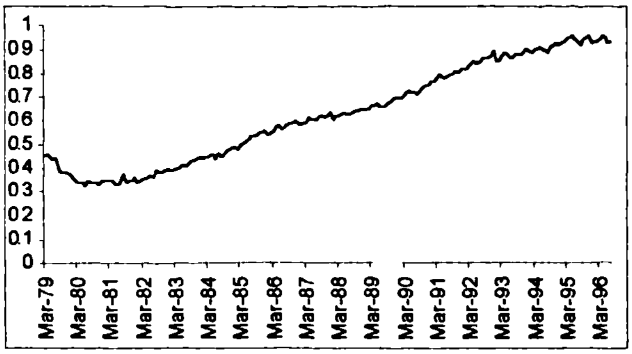


Figure I9: ΔINFD

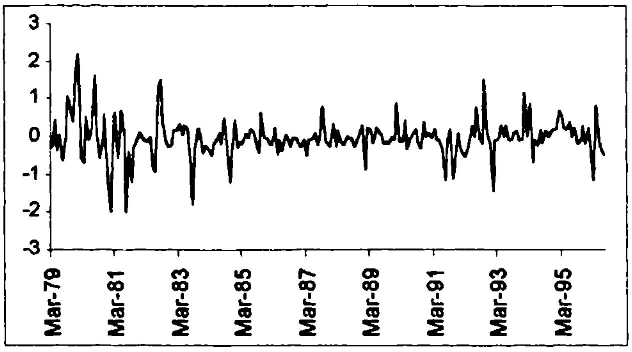


Figure I10: IPD

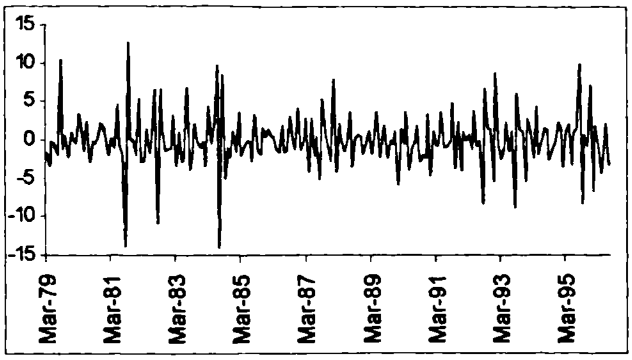


Figure I11: ΔRERD

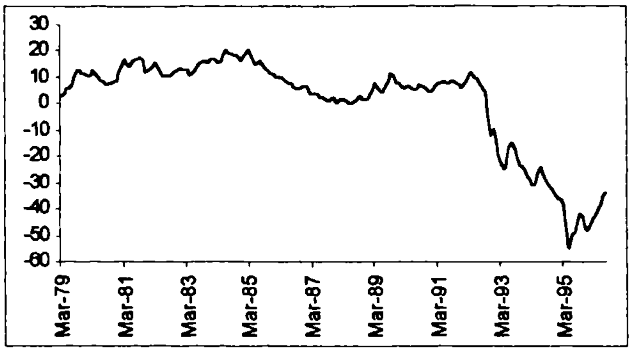


Figure I12: TBD

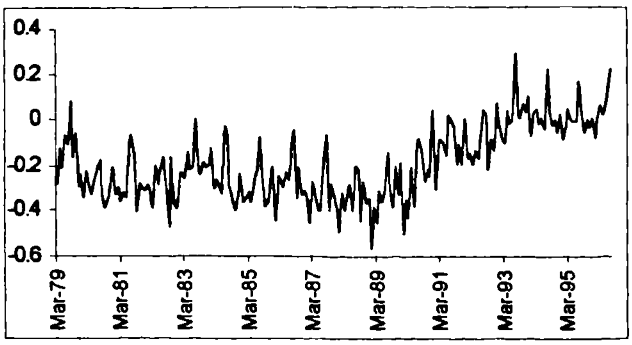


Figure I13: M2/RD

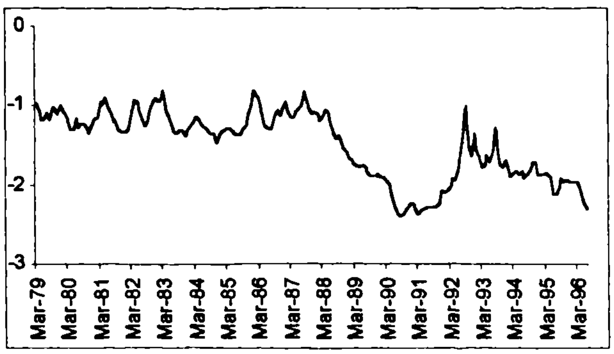
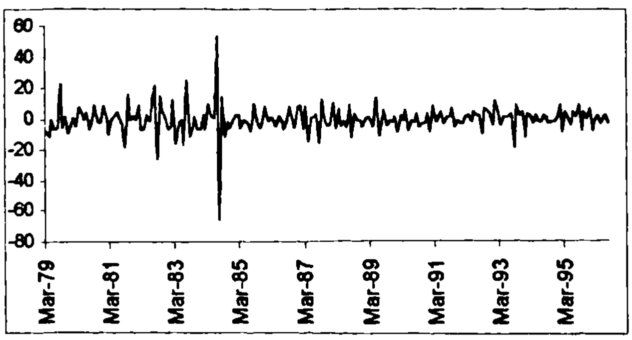


Figure I14: ΔGDPD



APPENDIX 4. 3.

Measurement of the Variables and Data Sources

The data sample includes France, Italy, and Germany and covers the period from March 1979 to July 1996. The study requires monthly data on the dependent variables and the "information variables" plus a record of the dates of the most significant political events for the ERM. All variables with an asterisk denote German variables. ln stands for the natural logarithm.

Variables Used in the Index of Exchange Market Pressure

Exchange Rates

The nominal exchange rate between the domestic currency and the German mark, E, is the spot middle rate in domestic currency per mark. Source: *Bundesbank Spot Middle Rates in Frankfurt, line BDWU5007 for the Italian lira and BDWU5012 for the French franc*[37]. The depreciation rate of the domestic currency against the German mark, e, is constructed as follows: $e = 100*\ln(E_t/E_{t-1})$.

Interest Rates

The nominal short-term interest rate, i, is the money market rate; i.e. the monthly average of rates for day-to-day loans against private bills in annualised percentage rates[38]. Source: *International Monetary Fund (IMF), International Financial Statistics, line 60B..*.

Reserves

Reserves, RES, are I.M.F Position in foreign exchange holdings (at current prices) expressed in Special Drawing Rights (SDR). Source: *International Monetary Fund (IMF), International Financial Statistics, line 1D. SA..* Reserves are then expressed in domestic currency using the national currency / SDR exchange rate. Source: *International Monetary Fund (IMF), International Financial Statistics, line ..RB..*

[37] BDWU5007 is originally expressed as DEM/ITL1000 but then substituted for ITL/DEM1. Likewise, BDWU5012, given in DEM/FRF100, is transformed to FRF/DEM1.
[38] That is, the rate at which short-term borrowings are effected between financial institutions.

Variables used to estimate realignment expectations

The data set consists of daily observations on interest and exchange rates for France, Italy and Germany collected in August 1996 by the Bank of International Settlements (BIS). The data sample begins with the onset of the ERM on March 13, 1979 and ends on July 28, 1993 for France and August 12, 1992 for Italy. The interest rates are annualised one-month Euro-interest bid rates recorded at 10 a.m. Swiss time. The spot exchange rates are ECU rates recorded at 2.15 p.m. Brussels time (prior to September 1988: 2.30 p.m.) as communicated by the Commission of the European Communities.

Explanatory Variables associated with the First Generation Approach

Economic Fundamentals

Nominal GDP, NGDP, is the sum of final expenditure at current prices. Source: *IMF, International Financial Statistics, line 99B.C.* Monthly observations of nominal NGDP, were obtained by regressing the quarterly series of GDP on quarterly series of Industrial Production and then intrapolating using monthly observations of Industrial Production.

Debt, DEBT, is outstanding debt of the central government. The distinction between domestic and foreign debt is based either on the residence of the lender or on the currency in which the debt instruments are denominated. Source: *Domestic and foreign currency denominated government debt are IMF, International Financial Statistics, lines 88B..A and 89B..A...for France and IFS line 88B...A for Germany and Italy.* The debt indicators are built as follows: $\text{DEBT}=(\text{DEBT/NGDP})_t$; and $\text{DEBTD}=\ln(\text{DEBT/NGDP})_t-\ln(\text{DEBT*/NGDP*})_t$.

The Real Exchange Rate, RER, is compiled from nominal effective exchange rate index and from the cost indicator of relative normalised unit labour costs in manufacturing. The measure is expressed as an index (1990=100) whose increase signals an appreciation or loss of competitiveness. Source: *International Monetary Fund (IMF), International Financial Statistics, line reuf*. The indicators are built as follows: $\Delta\text{RER} = 100*\ln(\text{RER}_t / \overline{RER})$; where $\overline{RER} \equiv$ Average RER over the sample period; and $\Delta\text{RERD}=100*[\ln(\text{RER}_t/\overline{RER})-\ln(\text{RER}_t*/\overline{RER}*)]$;

Imports, M, are the value of total c.i.f. imports expressed in domestic currency. Exports, X, are the value of total f.o.b exports also expressed in domestic currency. Source: *X: IMF, International Financial Statistics, line 70; M: IMF, International Financial Statistics, line 71.* The Indicators are TB, the Trade Balance, computed as $TB=\ln(X_t/M_t)$; and $TBD=100*[\ln(X_t/M_t)-\ln(X_t*/M_t*)]$, the Trade Balance Differential.

Inflation, INF, is the rate of change in the consumer price index, expressed as an annualised percentage. Source: *IMF, International Financial Statistics, line 64...X.* The indicators are $\Delta INF = INF_t - INF_{t-1}$; and $\Delta INFD = (INF_t - INF_{t-1}) - (INF_t* - INF_{t-1}*)$.

Indicators consistent with Second Generation Models

Financial Variables

Money supply is the monetary aggregate, M2, at current prices. Source: *National Government Series, line FRM2RMNYA for France; and OECD Main Indicators, line OCM2MNA for Germany and Italy.* The indicator of capital outflows is calculated as natural logarithm of the ratio of money supply (M2) to reserves (RES): $M2/R=\ln(M2/RES)_t$; and $M2/RD=\ln(M2/RES)_t-\ln(M2*/RES*)_t$;

External variable

The US dollar - German mark exchange rate, DM\$, is the end-of-period spot rate in German marks per dollar. Source: *National Government Series, line USX$DMK.* The German mark depreciation rate is calculated as $\Delta DM\$=100*\ln(DM\$_t/DM\$_{t-1})$. That is, the higher $\Delta DM\$$, the more the mark depreciates.

Macroeconomic Fundamentals

Real Output Growth

Real GDP, GDP, is constant price GDP, seasonally adjusted (base year = 1990). Source *IMF, International Financial Statistics, line 99B.R.* Again, monthly GDP was obtained by intrapolation using monthly industrial production series. The growth indicators are: $\Delta GDP=100*\ln(GDP_t/GDP_{t-1})$; and $\Delta GDPD=100*[\ln(GDP_t/GDP_{t-1})-\ln(GDP_t*/GDP_{t-1}*)]$.

The Industrial Production index, IP, is an indicator of current economic activity. Its coverage comprises mining, quarrying, manufacturing, electricity, gas and water. The index is compiled using the Laspeyres formula (1990=100) and is seasonally adjusted. Source: *IMF, International Financial Statistics, line 66..CE*. The Indicators are equal to $\Delta IP=100*[\ln(IP_t/IP_{t-1})]$; and $IPD=\ln(IP_t/IP_t*)$.

Unemployment

The unemployment rate, UR, is the standardised total unemployment rate (seasonally adjusted). Source: *National Government Series, line TOTUN%E*. The indicators, ΔUR and ΔURD, are equal to $\Delta UR=UR_t-UR_{t-12}$; and $\Delta URD= UR_t-UR_t*$.

Chapter 5
Exchange Market Pressure

5. 1. Introduction

Empirical studies differ with respect to their definition of a currency crisis. Most examine extreme and infrequent devaluations, whilst others consider even frequent devaluations[1] and thus allow for a broad definition of a currency crisis. Yet another set of empirical investigations extends the concept of crisis to both "successful" speculation that results in a devaluation, and "failed" attacks repelled at the cost of large losses of international reserves and extremely high interest rates. This latter approach is based on a so-called index of Exchange Market Pressure[2] that is adopted and explained in the present chapter.

Theoretical considerations suggest that an ideal index of market pressure would be derived from the estimation of excess demand for foreign exchange in a model of exchange rate determination. That is, speculative pressure should be a parametric function of fundamentals such as the rate of growth of domestic credit, the level of income and the interest rate differential. However, much of the literature emphasises the failure of models linking the exchange rate to variables such as money stock, interest rates and other macroeconomic fundamentals in both the short and intermediate run[3].

Accordingly, any particular indicator of exchange market pressure is only as justifiable as the theoretical model used to generate it. In a fixed exchange rate system, market pressure will be dominated by changes in reserves and interest rates, whilst in a floating rate system, changes in the level of pressure will be dominated by exchange rate changes.

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[1] These include Frankel & Rose (1996), Klein & Marion (1997) and Flood & Marion (1995).
[2] See for example Eichengreen et al. (1995), Sachs et al. (1996) and Kaminsky & Reinhart (1996).
[3] See Frankel & Rose (1994) and Taylor (1995a&b) for complete surveys of the economics of exchange rates.

In theory, a central bank always has the possibility of reducing its monetary base adequately so as to raise the interest rates to a level that will deter speculators from going short in the domestic currency; and vice versa when the domestic currency grows strong. Problems nonetheless emerge in reality as central banks typically refrain from defending an exchange rate peg without regard to the side effects on the rest of the economy.

In the Escape Clause approach to currency crises, the authorities should use reserves and exercise other policy instruments -such as the interest rate- in the face of possible changes in the exchange rate[4]. However, the bottom line is that decisions by the government will directly depend on its objective function and therefore on the net benefit of defending the currency peg. Inasmuch as there are many circumstances in which market pressure can make a stable system become unstable, there also exist many ways to model the costs and benefits of defending a currency.

The approach in this chapter is to adopt a concept of Exchange Market Pressure that is equally relevant to varying degrees of exchange rate management but, most importantly, is related to the currency crisis literature. Indeed, the proposed variable contemplates changes in the exchange rate, reserves and interest rates to measure exchange market pressure, and thus, is believed to capture the extent to which a government may be tempted to abandon the exchange rate peg.

It was observed in Chapter 2 that both generations of currency crisis models suggest that one should expect to see the foreign exchange market experience long periods of relative calm punctuated by short and sharp periods of speculative attack that cannot be detached from their economic environment. The empirical literature reviewed in Chapter 2 also revealed that exchange market expectations are subject to major regime shifts. It was also argued in Chapter 3 that the franc and the lira provide interesting scope for studying currency crises because of their prominent positions in the ERM and their unique and yet different characteristics. Chapter 4 then put forward a modelling methodology (the Markov Regime Switching Model with Time-Varying Transition

Probabilities) to address these central hypotheses. The purpose of this chapter is therefore to apply the methodology to the index of EMP for France and Italy.

The research undertaken in this chapter differs from previous empirical studies on currency crises in that, although many employ the index of Exchange Market Pressure, none so far has applied the proposed modelling methodology to characterise the dynamics of the index.

Section Two derives the measure of Exchange Market Pressure from a portfolio balance model and describes its structure. Sections Three clarifies critical issues related to the strategy followed in the course of the empirical analysis. Sections Four and Five analyse the results of the estimation for the franc and lira, respectively. Section Six compares the results for the two currencies, relates them to the existing evidence and concludes.

5.2. The Concept of Exchange Market Pressure (EMP)

5. 2. 1. Framework

Girton & Roper (1977) first introduced the concept of Exchange Market Pressure to model how excess demand (supply) for foreign currency leads to a rise (fall) in the price of foreign exchange and a fall (rise) in domestic reserves of foreign currencies.

To illustrate the concept of EMP, consider a simplified version of the framework used by Girton & Roper. Assume a standard money demand function. The percentage change in base money, h, is determined by the percentage change in the price level, p, by the percentage change in interest rates, Δi, and, by the percentage change in real income, y:

$$h \quad p - \alpha \Delta i + \beta y \qquad (1)$$

where α is the interest-rate semi elasticity for money demand and β is the income elasticity for money demand.

[4] In practice, in Stage Two of the plan for EMU, governments may decide to devalue the domestic currency only

Money supply is expressed as the sum of domestic credit, D, and foreign reserves, R, (i.e. the money multiplier is assumed to be unity), so that:

$$H \quad D + R \tag{2}$$

Define r as the percentage change in reserves and d as the percentage change in domestic credit. Assuming moreover that the domestic and foreign demand for money are identical and that there is continuous equilibrium in the money market, we can then write:

$$(r - r^*) + (d - d^*) \quad (p - p^*) - \alpha \Delta(i - i^*) + \beta(y - y^*) \tag{3}$$

where an asterisk denotes a foreign variable.

Given that the domestic and foreign money markets are linked by purchasing power parity, $e \;\; p - p^*$ (where e is the depreciation rate of the domestic currency)[5], we obtain:

$$e - (r - r^*) - (d - d^*) + \alpha \Delta(i - i^*) - \beta(y - y^*) \tag{4}$$

Girton & Roper define EMP as the left-hand-side of equation (4) and therefore measure pressure as a combination of exchange rate depreciation and losses of domestic reserves relative to foreign reserves. Equation (4) also suggests that EMP is positively related to domestic credit growth relative to foreign credit growth and to the relative change in nominal interest rates, and negatively related to changes in relative real GDP growth.

5. 2. 2. Measurement of the Index of EMP

Whilst the Girton-Roper definition and measure of EMP derive from a highly restrictive monetary model, Weymark (1995, 1997, 1998) subsequently proposes a general definition of EMP[6], also composed of changes in the exchange rate and official foreign exchange reserves. Yet Weymark's measure is derived from the estimation of small open economy model with rational expectations. Estimation of a model to give weights to the components of the index has serious implications for subsequent empirical work.

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for well-defined policy purposes and in exceptional circumstances.

[5] Note that Girton and Roper use the absolute -rather than relative- purchasing power parity.

[6] Weymark (1995, 1997a&b, 1998) define "EMP measures total excess demand for a currency in international markets as the exchange rate change that would have been required to remove this excess demand in the absence

For example, the Girton-Roper measure of EMP is consistent only with a restricted group of models. In this respect, model-independence is a more attractive notion as regards the interpretation of the index. Accordingly, neither the components of the operational index employed in this thesis nor the weights they are assigned derive from the estimation of the structural framework of the economy.

If capital leaves of a country, its government will have the choice to let the currency depreciate or to defend the peg by increasing interest rates and running down reserves. The proposed index is a linear combination of the changes in exchange rates, interest rates and international reserves. Inasmuch as the literature habitually views speculative attacks as sudden massive restructuring of portfolios, whereby market participants attempt to prevent losses, or reap gains, from an expected change in the exchange rate regime, it can reasonably be expected that such circumstances would be identified by the proposed index.

For other reasons exposed below, the EMP index is defined as follows:

$$EMP = w_1\, e + w_2\, \Delta(i - i^*) - w_3\, r \qquad (5)$$

where e is the rate of depreciation of the domestic currency vis-à-vis the German mark; r is the percentage change in domestic reserves of foreign exchange[7] and $\Delta(i - i^*)$ is the change in the short-term interest rate differential against Germany.

Because the volatility of exchange rates, reserves and interest rate differentials is very different, an unweighted index would consequently result in the most volatile component(s) dominating the index. Eichengreen et al. (1994, 1995) deal with the problem by applying intuitive volatility smoothing weights -they weigh the three components so as to make their conditional volatilities equal. Kaminsky et al. (1998) and Sachs et al. (1996) also apply weights given by the relative precision of each series so that the variances of the components of the index are equal. The relative precision is

of exchange market intervention, given the expectations generated by the exchange rate policy actually implemented".

defined as the inverse of the each series' variance -the precision of that series over the sample period- over the sum of the relative precisions of all the series composing the index. Finally, Pentecost et al. (1996) undertake a Principal Components analysis of the three component series and assign the weights given by the principal components.

Due to lack of data, neither Kaminsky et al. (1998) nor Sachs et al. (1996) include interest rates in the definition of the index. Note also that, Eichengreen et al. (1994, 1995) use the differential proportional change between domestic and foreign reserves; whilst Pentecost et al. (1996) assume that there is no role for intervention by the foreign authorities. The argument put forward by Pentecost et al. against the inclusion of German reserves in the index is that "interventions by the Bundesbank account for only a small proportion of total ERM interventions and are predominantly in the US dollar market", and "Germany would appear to sterilise its interventions within any quarter to a larger extent than other EU members, such as France and Italy".

Although the extent of the intervention could be captured by analysing changes in reserves of each country relative to changes in German reserves[8], two major shortcomings remain that only restricted data on exchange rate intervention would overcome. First, although intervention of several central banks to defend a same currency was a fundamental feature of the ERM, intervention by third countries –other than Germany- would not be detected. Second, by using changes in domestic reserves relative to Germany's, one is attributing intervention by the Bundesbank to a particular country. For example, if one looks at the index of EMP for the Italian lira, a large percentage drop in Italy's reserves relative to Germany's could result from extensive German intervention in support of the French franc, indicating an apparent attack on the lira where in fact there is not.

Since there is no clear guidance as to the weights to attach to each series, and on whether or not one should employ domestic reserves relative to Germany's, we compared the results obtained from the application of the Markov Switching Model

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[7] Following Eichengreen et al. (1994, 1995), Pentecost et al. (1996), Kaminsky et al. (1998), Sachs et al. (1996) and Weymark (1995, 1997a&b, 1998) reserves are expressed relative to the monetary aggregate M1.

[8] Given that the German mark surely was the strong-currency throughout the sample

with the different weighting systems. The questions of weighting and foreign reserves indeed emerged as essentially empirical issues. The relative precision and principal component alternatives were tested and compared. The latter method turned out to produce inferior results to the former in terms of coefficient consistence and significance. In fact, the principal component analysis proved to give so much weight to changes in reserves[9] that the other two components were of little importance. Also, the switching model results obtained with an index unrelated to the German percentage change in reserves were compared to the findings with the alternative index containing German reserves. It emerged that the former generates superior inference, in terms of identification of the crisis periods[10] as well as in terms of coefficient significance[11]. The approach adopted in the thesis, after extensive experimentation with different indexes, is therefore to weight each component series by its respective relative precision over the sample period and to exclude German reserves.

Criticism of the index has emerged on the grounds that the choice of the weights is ad-hoc. Another major caveat results from the fact that international reserves are a noisy measure of intervention since the authorities typically use off-balance-sheet transactions which, by definition, are not reported[12]. Also, one needs to bear in mind that in most countries there were capital controls at least in the first half of the sample and that, due to the periodicity of the data, a crisis initiated and countered within a month will not be identified by the proposed index. Despite all its shortfalls, the choice of approach is justified by the good performance of the studies that use the index.

5. 3. Strategic Methodological Issues

[9] Whether reserves are domestic reserves only or relative to Germany's.
[10] The calculated statistic for prediction power (TP) was lower with the index unrelated to German reserves.
[11] The two means for the index did not appear significant when German reserves were taken into account.
[12] Off balance sheet operations involve contingent commitments or contracts which are not normally captured as assets and liabilities under conventional accounting procedures. These may include, for example, forward foreign exchange contracts, credit lines and currency swaps, options and futures.

Estimation is conducted in two stages[13]. The Fixed Transition Probability (FTP) Markov Regime Switching model is first applied in order to determine the correct dynamic specifications of the model and to obtain starting values for the Time-Varying Transition Probabilities (TVTP) model[14]. In the second stage, we proceed to allow the transition probabilities to depend on economic fundamentals. The sample period runs from March 1979 to July 1996 for both the French franc and Italian lira.

The first step of the Markov switching technique consists in modelling the index of EMP as deriving from one of two possible states: 'normal' or 'crisis'. Presumably, pressure grows as domestic reserves of foreign exchange decrease, the interest rate differential widens and the exchange rate depreciates. A crisis should then be identified by a positive and large value of the index associated with a high variance; and a stable period by a small mean and a low variance. The model characterises the two regimes followed by the index and, thereby, distinguishes the speculative attack episodes from the tranquil periods.

The first generation type of currency crises model shows that a fixed peg is not sustainable under expansionary fiscal and monetary policies and determines the timing of the attack by the exhaustion of reserves. In the recent literature, an unhealthy economy is also a necessary preamble to a currency crisis but its timing may not be justified by any noticeable change in the macroeconomic variables. Accordingly, a currency crisis should be preceded by a deterioration of macro-fundamentals[15] and last longer as the latter deteriorate. A tranquil period, on the other hand, should be induced and lengthened by better fundamentals. By allowing the transition probabilities to be state-dependent, the objective is to assess the extent to which the state of the EMP index is sensitive to the various explanatory variables.

Different lags were tried in the course of the investigation but estimation with more than two lags generally produced inferior findings. Also, the transition probabilities

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[13] Convergence to the global maximum was relatively robust to the choice of initial values. The second order derivatives of the log likelihood were calculated with respect to each parameter to give the respective asymptotic standard errors.

[14] Following a suggestion by Filardo (1994) and Engel & Hakkio (1996) the initial parameter values for the means and variances are set equal to the final results of the FTP model.

were modelled as dependent on a variable with different lags. For example, using current and one-month-lagged explanatory variables, the transition probabilities become:

$$p_{nn} = \frac{\exp(\delta_n^0 + \delta_n^1 z_t + \delta_n^2 z_{t-1})}{1+\exp(\delta_n^0 + \delta_n^1 z_t + \delta_n^2 z_{t-1})} and\, p_{cc} = \frac{\exp(\delta_c^0 + \delta_c^1 z_t + \delta_c^2 z_{t-1})}{1+\exp(\delta_c^0 + \delta_c^1 z_t + \delta_c^2 z_{t-1})}.$$

Other combinations (z_{t-1} with z_{t-2}; z_{t-2} with z_{t-3}, etc.) were also explored but none produced any statistically significant results for the δ coefficients whenever convergence was reached. In fact, it proved difficult to achieve convergence when the transition probabilities were functions of more than one variable, possibly because the number of parameters to estimate is too large for the algorithm to handle.

Likewise, although it appeared tempting to investigate the influence of combinations of different variables on the transition probabilities, once again it turned out to be a troublesome task because of convergence problems. Furthermore, the problem arose that combinations of variables would have to be selected somewhat arbitrarily. Experimentation with various indicators of contagion –European average depreciation rate, European average interest rate and European average real exchange rate- did not provide any significant results either. This is in sharp contrast with the results of Eichengreen et al. (1996) and Glick & Rose (1998) who find striking evidence of contagion effects in the EMS. One plausible explanation for such lack of evidence is that the choice of the contagion and external variables was not appropriate. However, application of the tests devised by Eichengreen et al. and Glick & Rose would require using a completely different model which is not the object of the present thesis. The other alternative is to follow the -somewhat uninformative- dichotomous classification of Esquivel and Larraín (1998); i.e. introduce a dummy if there has been a crisis in a neighbouring country in the previous six months. One problem however is that it is well established that the EMS crises took place simultaneously (or at least in the same month). Another drawback of Esquivel & Larraín' s method is that such a proxy would not actually explain the channels of contagion[16].

[15] Domestic fundamentals in isolation or domestic fundamentals relative to Germany's
[16] Note that these methodological issues also apply to Chapter 6.

As a consequence, the results presented hereafter cover only the experimentation carried out using current, one-month-lagged and two-month-lagged variables individually. There are three distinct sets of variables: domestic variables; domestic variables relative to Germany; and one external variable. The rationale for looking at the domestic variables in reference to another country's lies in the fact that market participants would normally tend to compare the performances of different economies. Even if the domestic economic fundamentals are healthy, it may be that the centre economy does better, in which case pressure on the domestic currency could arise. The choice of Germany as the reference country is justified by the central role of the German mark as the consistently strong currency of the ERM[17]. Indeed, although the ERM was designed to be a symmetric system, all realignments implied devaluations of the currencies with respect to the mark.

Finally, whilst the majority of papers observe the EMS until August 1993 at the most, we believe that renewed pressure emerged after August 1993 and extend the investigation to the post-enlargement period. Various sub-periods were investigated and, since results proved to be sensitive to the sample period used, it was decided to keep the long sample unless specification tests suggested otherwise.

5. 4. Results for the French Franc

Figure 1 plots the index of EMP for the French franc from March 1979 until December 1996[18]. The graph suggests that the series is stationary and depicts relatively high volatility throughout the whole sample period. Major ups and downs of the French index of EMP occur in 1982/1983 and in January 1987. There follows a relatively placid period before a series of turbulent months (including the end of 1992 and part of 1993 as well as the first half of 1995).

[17] Eichengreen et al. (1995, 1996) and Martinez (1999), among others, also analyse domestic fundamentals relative to Germany's.

[18] The weights for the domestic currency depreciation rate, change in interest rate differentials and the change in domestic reserves of foreign exchange are 0.46, 0.49 and 0.05, respectively.

Estimation of the Markov Regime Switching model with FTP is first conducted in order to identify the correct specifications of the model and to obtain starting values for the TVTP model.

5. 4. 1. Estimation of the Markov Regime Switching Model with Fixed Transition Probabilities (Selection of the model and Identification of the Two Regimes)

Results for the static Fixed Transition Probability model (FTP) in Table 1a show that the stable state is depicted by a small negative mean and low variance. The crisis state, on the other hand, appears to be described by a large positive mean value of the index associated with a much higher variance. In this respect, the stable state describes a situation in which there is an insignificant and stable appreciation of the domestic currency and/or diminishing interest rate differentials with Germany and/or gains of domestic reserves of foreign exchange; i.e. confidence in the franc. A crisis is identified as a situation where there is high and volatile pressure on the domestic currency, synonymous with a large depreciation, and/or increasing interest rate differentials and/or a loss of domestic reserves.

For the static model, the White test reported in Table 1b rejects the null hypothesis of no serial correlation at the 1-percent significance level. Having said that, the LM tests indicate the presence of autoregression in state n only. The White and LM tests suggest that there is no significant ARCH effect and the hypothesis that the state follows a Markov chain is not rejected. Andrews' test for a permanent shift in the mean, as plotted in Figure 2, displays no evidence of a permanent shift in the means.

As far as the TP statistic is concerned, the model TP is compared to the benchmark TP (constant and equal to the historical fraction of crisis months; i.e. $\overline{TP}$=0.1722 based on Table 2). Looking at Table 1a one can readily conclude that the model is successful with respect to its forecast of in-sample turning points, since TP=0.1523 is smaller than the benchmark.

Table 1c presents the results of an autoregressive -AR(1)- model with a constant autoregressive term across states[19]. The autoregressive term is significant and the model performs better than the static model in terms of the Schwarz Criterion (SC), Turning Point statistic (TP) and Mean Square Error (MSE). The Box-Pierce Q-statistics in Table 1d show that the autoregressive model is free from autocorrelation or ARCH problems.

However, because the static model shows a problem of autocorrelation in state n only, an autoregressive model is estimated that allows for the autoregressive terms to vary across states. Results are presented in Table 1e. The results show that the autoregressive term is significant for state n but not for state c. Therefore, a Markov Regime Switching model that allows for autoregression in state n only is presented in Table 1f. The latter model appears to fit the data better. The specification with TP=0.1331 does better than the models in Tables 1a. Although the Mean Squared Error for the output forecast derived from the model in Table 1f (MSE=3.2835) is slightly worse than that of the static model (MSE= 3.1545), the Schwarz Criterion is the highest for the AR(1) specification in state n only (-217.6). Therefore, the specification reported in Table 1f will serve as the basic model for all further estimations with Time-Varying Transition Probabilities.

The chosen model shows that periods of stability are relatively long lasting. In fact, the length of stay in the normal state, D_n, is $D_n = 1/(1-p_{nn})$=14 months approximately, whilst the crisis state lasts 4 months.

Figure 3 plots the unconditional smoothed probabilities that the index was in a state of crisis (or high speculative pressure) at each date in the sample. A crisis period is defined as a month in which the smoothed probability of being in the crisis state (that is, conditional upon all observations in the sample) is greater than 0.5[20]. Calculation of these probabilities uses the full sample (209 observations) and the maximum likelihood

[19] Note that larger orders were tried for the regressive terms but did not prove significant.
[20] Since the values of the inferred probabilities are close to zero or one, the identification of crisis episodes does not change substantially when one chooses 0.6, 0.7 or 0.8 as a threshold.

estimates of the parameter vector of the FTP model to draw an inference about the state of the index each month.

Examining Figure 3, one can see that the Markov Switching model identifies several prominent short exchange rate crises, separated by long periods of stability. The periods of high pressure thereby identified are reported in Table 2 (column 1) and compared to the actual past turbulent phases for the franc (column 2). The index of EMP displays very high probabilities of being in the crisis state in April 80; March 81 to September 82; February to April 83; January 87; November 87; August 92 to August 93; March 95 and October 95. The identification of the crisis months fits relatively precisely the months in which either a realignment took place or speculative pressure against the franc was reported to be intensive (note that the value of the TP statistic corroborates this conclusion). On the other hand, not all realignments are identified as crisis periods either because they did not concern the franc or because they were merely extrinsic decisions to realign the currencies on grounds of inflation convergence within the ERM rather than decisions made due to intolerable speculative pressure[21].

Table 1a: Static Model

μ_n	μ_c	σ_n^2	σ_c^2	p_{nn} (%)	P_{cc} (%)	Lik. / SC	M.S.E.	T.P.
-.1173	1.076*	1.1839*	8.8384*	92.02*	80.14*	-208.0	3.1545	.1523
[-1.094]	[2.280]	[5.901]	[4.272]	[116.2]	[22.62]	-224.0		

(*) denotes significance at the 5 percent level. Values within square brackets below the coefficients are t-values. The value of the log-likelihood function is Lik.

Table 1b: Specification Tests for the Static Model

White test F(4, 203)		**LM Tests** F(1, 204)	
Serial Correlation in both regimes	3.5197*	Serial Correlation in regime 0	5.7055*
ARCH effects in both regimes	1.8653	Serial Correlation in regime 1	0.6328
Markov Specification	1.4252	Serial Correlation across regimes	4.5913*
		ARCH effects in both regimes	2.1159

The 5 percent critical values for the F(4, 203) and F(1, 204) are 3.32 and 6.63 respectively; and the 1 percent critical values are 2.37 and 3.92 respectively. (*) denotes significance at the 1 percent level.

[21] These episodes include July 85, April 86 and Aug. 86.

Table 1c: AR(1) with ρ Constant Across States

μ_n	μ_c	ρ	σ_n^2	σ_c^2	p_{nn} (%)	p_{cc} (%)	Lik./SC	M.S.E.	T.P.
-.0834	1.376*	.1728*	1.211*	8.893*	92.93*	77.15*	-199.8	3.024	.132
[-.699]	[2.182]	[2.526]	[6.31]	[4.119]	[25.60]	[6.499]	-218.5		

Table 1d: Box-Pierce Q-statistics on Residuals for Autocorrelation (A) and Heteroskedasticity (H)

	Q(1)	Q(2)	Q(3)	Q(4)	Q(5)	Q(6)	Q(7)	Q(8)	Q(9)	Q(10)	Q(20)
A	.153 [.696]	1.075 [.584]	1.341 [.719]	1.369 [.849]	1.937 [.858]	3.906 [.689]	4.942 [.667]	5.356 [.719]	5.987 [.741]	16.18 [.094]	27.65 [.118]
H	.5723 [.449]	1.225 [.542]	1.454 [.693]	2.058 [.725]	2.062 [.840]	2.068 [.913]	2.071 [.956]	2.449 [.964]	2.675 [.976]	19.96* [.029]	24.05 [.240]

$\chi^2(m)$ tests. p-values in square brackets. (*) denotes significance at the 5 percent level

Table 1e: AR(1) Model with ρ Dependent on State

μ_n	μ_c	ρ_n	ρ_c	σ_n^2	σ_c^2	p_{nn} (%)	p_{cc} (%)	Lik. / SC	M.S.E.	T.P.
-.0858	1.313*	.242*	.0383	1.187	8.67*	92.74*	76.78*	-198.9	3.304	.1323
[-.762]	[2.65]	[3.13]	[.346]	[6.97]	[4.26]	[143]	[20.5]	-220.3		

(*) denotes significance at the 5 percent level.

Table 1f: AR(1) Process in State n only

μ_n	μ_c	ρ_n	σ_n^2	σ_c^2	p_{nn} (%)	p_{cc} (%)	Lik. / SC	M.S.E.	T.P.
-.0877	1.312*	.2437*	1.188*	8.676*	92.85*	77.04*	-198.9	3.2835	.1331
[-.785]	[2.742]	[3.014]	[6.913]	[4.294]	[140.6]	[20.42]	-217.6		

(*) denotes significance at the 5 percent level.

Figure 1: French Index of Exchange Market Pressure

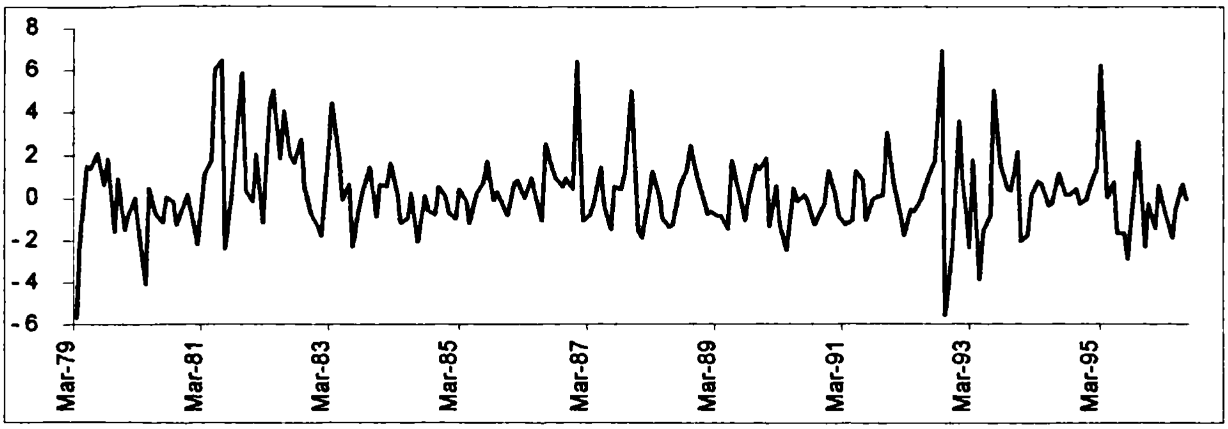
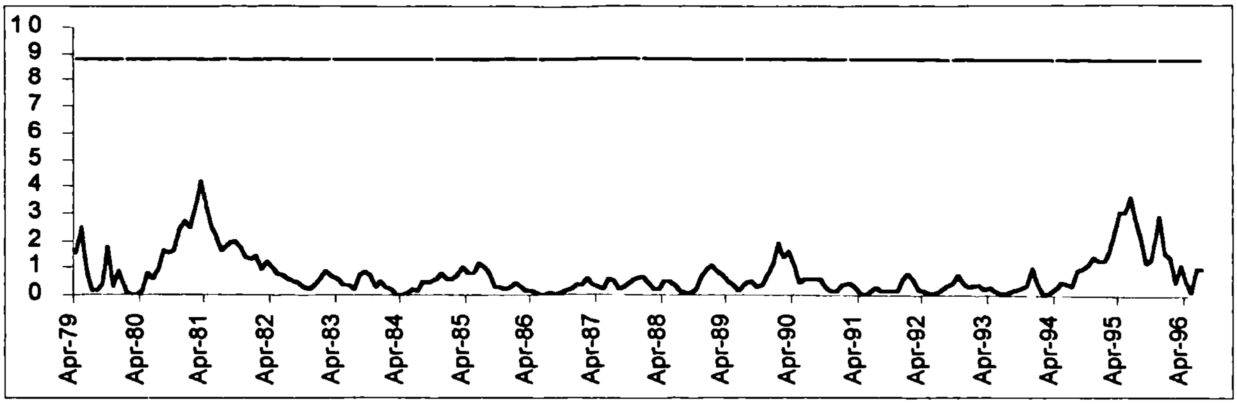


Figure 2: Andrew's Test for Permanent Shift in the Mean



The asymptotic 5 percent critical value for Andrew's test is 8.85 and the 1 percent critical value is 12.35. Clearly the assumption of no permanent shift in the mean cannot be rejected.

Figure 3: Smoothed Probability of Being in the Crisis State

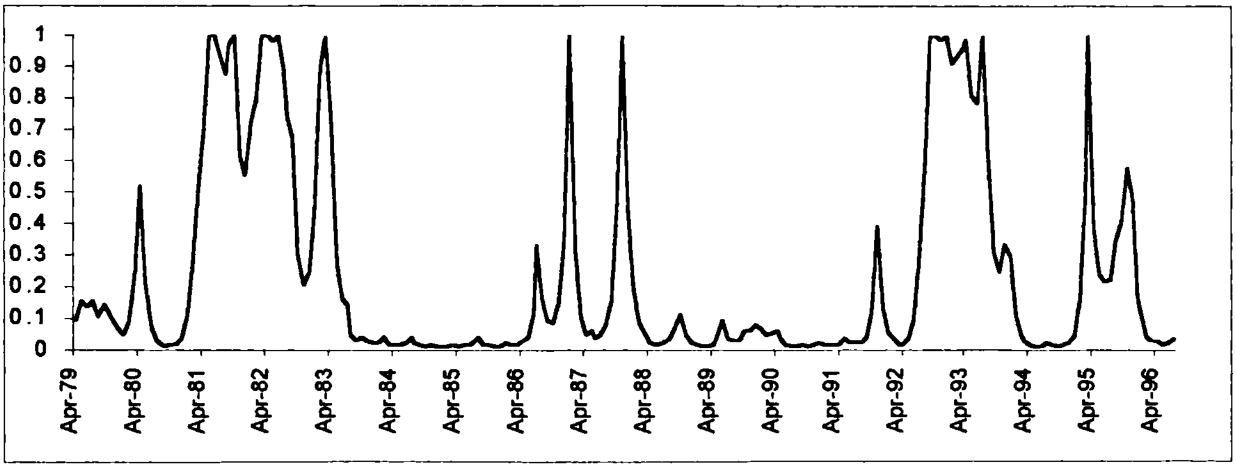


Table 2: The French Crises

Model	History
	From Aug. to Sept. 79, the French authorities need to intervene continuously to restrain the divergence of the FRF spot exchange rate from its central parity. DEM revaluation by 2% against all other currencies in Sept..
April 80	*April 80*: EMS comes under pressure very briefly. The German authorities need to intervene heavily to avoid a depreciation of the DEM.
April 81 to Sept. 82	*March 81*: Third ERM realignment (ITL: +6% against the DEM). The FRF declines (following an upward move in US interest rates and the nervousness about a Socialist victory in the French Presidential elections). From May to Sept. the FRF is unstable, kept within the band only with massive intervention.

	Oct. 81: Fourth ERM realignment. Largest bilateral change yet seen in the ERM (the FRF is devalued by 3% and the DEM revalued by 5%). France spends $1.3 billion defending the FRF prior to the realignment. The ITL is also devalued. *Feb. 82*: Fifth ERM realignment (involves the BEF and the DKK only). The FRF is not devalued, the French money rates are raised by 3% points relative to Germany and the US, but tensions continue to increase in the market. *March 82*: The FRF is weak following the deterioration of the balance-of-payments and poor electoral results for the government. *April 82*: Strong upward pressure on the DEM. The FRF is pushed down by massive speculative attacks. *June 82*: Sixth realignment (the DEM and NLG are revalued and the FRF and ITL are devalued). This realignment implies an effective devaluation of the FRF against the DEM of almost 10%.
Feb. 83 to April 83	*March 83*: Seventh realignment (the FRF/DEM exchange rate is adjusted by 8%). General realignment. Pressure in the EMS comes to a head after the general elections in France and West Germany in March. Pressure is particularly high on the FRF despite intervention and exceptionally high interest rates.
	Dec. 85: Renewed tensions in the ERM emerge. The pressure requires intervention by the authorities as outflows from the dollar go into the DEM. *March 86*: Pressure intensifies on the FRF on expectations that a new government will win power at the National Assembly elections and will opt for an early devaluation. *April 86*: Ninth realignment (after the parliamentary elections of March, the FRF is devalued by 6% against the DEM and NLG). This devaluation of the FRF is the first major realignment since 1983. *Oct. & Nov. 86*: The FRF is affected by the domestic political and industrial situation despite significant increases in interest rates. The strength of the DEM against the dollar and expectations that German interest rates will not be cut lead to pressure in the EMS.
Jan. 87	*Jan. 87*: Eleventh Realignment. Foreign exchange markets are in turmoil as the dollar resumed its rapid fall at the end of 1986. The French authorities cannot keep the FRF away from its lower intervention margin as public sector strikes and risks of faster wage inflation emerge. Ex-post, the eleventh realignment is perceived as being provoked more by speculative unrest in currency markets then by macroeconomic divergence among the participants (which was the case for the previous ten realignments). The Bundesbank actually operates its largest ERM intervention in the period 1986-87.
Nov. 87	*Nov. 87*: The FRF suffers a period of pressure despite substantial intervention by the Banque de France, as the DEM benefits from the dollar's decline.
Aug. 92 to Aug. 93	*July 92*: The FRF comes under pressure and weakens rapidly. Short-term interest rates become more volatile and the interest rate differential with the DEM spreads. Both the Bundesbank and Banque de France intervene heavily in support of the franc. Given the unprecedented speculative pressure in the ERM in September, the Bundesbank intervene massively in support of the ITL, FRF and GBP. In November, the FRF falls under renewed pressure following the six percent devaluation of the POE and the ESP.

	Jan. 93: the FRF/DEM rate is at the limit of the maximum allowed. It then fluctuates violently due to uncertainty about the March election. Both the Banque de France and the Bundesbank intervene to support the FRF. French money market rates are raised substantially. *June 93*: The market's attention is focused on the weaker than expected French GDP and high unemployment rate and the reduction of short-term interest rates below German levels. Other wave of speculative pressure. In July, the French government attempts to lower interest rates. The situation worsens quickly. The Bundesbank and other European central banks spend an estimated DEM 60 billion buying the FRF., BEF and DKK. Yet, all three currencies end close to their ERM floors and, on Aug. 3rd, the fluctuation band is widened to 15%.
March 95	*Jan. 95*: Sharp fall in the FRF as the market is very sensitive to political rumours before the spring elections. *March 95*: The FRF falls to an all-time low against the DEM (5.5 percent below central parity).
Oct. 95	*Oct. 95*: New tensions emerge against the FRF

5. 4. 2. Time-Varying Transition Probabilities: The Role of Economic Variables

Tables 3 to 8 report the results of the estimation of the TVTP version of the Markov Switching model. To understand the economic significance of the explanatory variables, one may examine the plot of the TVTP for each state and each explanatory variable. It is important to recall that the TVTP must be interpreted as the probability of being in a specific state in some period t conditional on the state in period t-1. Therefore, the plot of the TVTP for each specific exogenous variable should provide some insight on the extent to which that variable can force switches from one state to the other. Additionally, it is possible to compute the value each explanatory variable needs to take in order to trigger a switch (i.e. for the probability of remaining a given regime to fall below 0.5). In the following, we present and discuss the results and TVTP plots for the variables that are statistically significant and theoretically consistent, and calculate their respective trigger values (i.e. the values that make the index of EMP change state).

In Tables 3 to 8, the mean in the crisis state (μ_c), the autoregressive coefficient (ρ_n), the two variances (σ_n^2, σ_c^2), and the independent coefficient for the transition probabilities from the normal state (δ_n^0) are all statistically significant. On the other hand, the mean of the normal state and half of the estimates of the independent coefficient for the transition probabilities from the crisis state (δ_c^0) are not statistically significant. So, although the normal mean takes relatively homogeneous values across all the results reported in Tables 3 to 8, there is a significance problem possibly due to the high variance of the normal state relative to its mean.

Table 3 summarises the findings as to the effects of the current French economic variables and German mark depreciation rate. Two parameters take the correct signs and are statistically significant in the crisis state, i.e. the change in the unemployment rate (ΔUR) and the trade balance (TB)[22]. Figure 4a plots the joint conditional probability of remaining in the crisis regime with TB as forcing variable. Although the plot is extremely volatile, an examination of the data reveals that the transition probability is close to unity in the periods the FTP model identified as crisis episodes. Exceptions include 87M01, 93M04-M08, and 95M03-M10 when the probability of remaining in the crisis state, p_{cc}, is less than 0.5. This suggests that, during most of French crises, trade balance deterioration did force the index of EMP to stay in the crisis regime. More precisely, p_{cc} is above the 0.5 critical value as long as TB is less than 0.004. It can be checked in Figure F5 of Appendix 4.1 that TB exceeds its trigger value only after the early 1990s. Likewise, Figure 4b, which plots the probability of remaining in the crisis regime with ΔUR as forcing variable, corroborates the suggestion that increasing unemployment contributed substantially to the crises. In effect, p_{cc} is close to unity in the first half of the 1980s and in the early 1990s (note that Figure 4b follows relatively closely the plot of ΔUR in Figure F7 of Appendix 4.1). Also, as soon as ΔUR is less than 0.218 percent (as is the case in the second half of 1980s and part of 1995[23]), p_{cc} falls below 0.5. Although the dollar depreciation rate (ΔDM$) in Table 3 is significant in the crisis state, its sign is not as predicted. Conversely, the variables whose parameters take the correct signs in both states (ΔIP,

[22] Note that TB is significant only at the ten percent level.
[23] See Figure F7 in Appendix 4.1.

ΔRER, and ΔGDP) or in the normal state only (DEBT, ΔINF, M2/R and ΔDM$) are not statistically significant.

Table 4 provides the results on the influence of the current differentials between the domestic and German variables. The real exchange rate differential (ΔRERD) is significant and takes the correct sign in the crisis state. The plot of the conditional probability of staying in the crisis regime with ΔRERD as explanatory variable in Figure 4c, shows that p_{cc} is close to unity, but for several occasions (81M04, 81M11, 82M07&08, 83M04&05, 86M05, 93M09 and 95M11). More precisely, as long as ΔRERD exceeds -2.68 percent, p_{cc} remains above 0.5. Figure F13 in Appendix 4.1. plots the variable ΔRERD and confirms that it is lower than its trigger value only on the listed occasions. No other economic factors affects the transition probabilities significantly. Several variables take the expected signs in both states (i.e. IPD, and ΔGDPD) and in the normal state (i.e. DEBTD, ΔINFD, and TBD) but are not statistically significant. Others (ΔRERD in the normal state and TBD in the crisis state) are statistically significant but display the wrong signs.

In Table 5, four one-month-lagged French economic factors have effects on regime switches. Industrial production and real GDP growth -ΔIP and ΔGDP- are statistically significant in explaining switches from the normal state. The probability of remaining in the normal state, p_{nn}, falls below 0.5 when ΔIP is less than -3.34 percent and ΔGDP is less than -0.178 percent. Figures 4d and 4g plot p_{nn} for one-month-lagged ΔIP and ΔGDP, respectively. The two plots are naturally closely related. They suggest that p_{nn} was very high throughout the entire period, but for a few months (86M07 for ΔIP and 82M09 and 86M07 for ΔGDP)[24]. Hence, it seems that once the index is in the normal regime, it is almost certain to remain in that state, unless ΔIP and ΔGDP take extremely low values. Figures F3 and F8 in Appendix 4.1 indeed show that ΔIP and ΔGDP rarely fall below their respective trigger values. The coefficients for the trade balance (TB) and change in the unemployment rate (ΔUR) are statistically significant[25] and take the

[24] In Figure 4g, the transition probability is also close 0.5 in 84M08 and 86M02.
[25] Although TB is only significant at the 10 percent level

expected signs in the crisis state. In fact, the results for one-month-lagged TB are similar to those for current TB so that Figure 4e is akin to Figure 4a and the conclusions are the same[26]. Likewise, the findings for one-month-lagged ΔUR are closely related to those for current ΔUR and the same comment applies (i.e. Figure 4f provides the same inference as Figure 4b)[27]. Several other parameters take the correct signs in both states (ΔRER), in the normal state (DEBT, ΔINF, M2/R and ΔDM$), or in the crisis state (ΔIP and ΔGDP) but are not significant. Note that ΔDM$ has, once more, a positive and statistically significant coefficient in the crisis regime.

Table 6 presents the results for one-month lagged differentials between French and German economic variables. The inflation differential (ΔINFD) affects the normal state significantly and has the expected sign. The plot of the conditional probability for ΔINFD in Figure 4h shows that the probability is close to unity throughout the entire sample period, with some exceptions -80M03, 82M05, 92M12- that all fall within the identified crisis episodes, and 94M03. In fact, p_{nn} falls below 0.5 only if ΔINFD exceeds 0.739 percent which indeed is rarely the case according to Figure F11 (Appendix 4.1). No other variable is statistically significant and theoretically consistent. The industrial production differential (IPD) and real exchange rate differential (ΔRERD) display the expected signs in both states but are not statistically significant. Other variables display the correct sign in the normal state (DEBTD, TBD and ΔGDPD), or in the crisis state (ΔINFD and M2/RD), but are not statistically significant. On the other hand, M2/RD is significant at the 10 percent significance level in the normal state but does not take the correct sign.

In Table 7, only one French economic variable provides significant evidence of two-month-lagged influence on the transition probabilities. Changes in the unemployment rate (ΔUR) have an effect on the probability to transit from the crisis state. In fact, the coefficients δ_c^0 and δ_c^1 for two-month-lagged ΔUR, are akin to those on current and

[26] The trigger value of one-month-lagged TB is 0.0059 percent, which is close to that of current TB.

[27] The value of one-month-lagged ΔUR that forces p_{cc} below 0.5 does not differ much from current ΔUR at 0.261 percent.

one-month-lagged ΔUR. As a result, Figure 4i is closely related to Figures 4b and 4f[28]. Although ΔINF and ΔRER take the expected signs in both states, their coefficients are not statistically significant. Similarly, DEBT and M2/R display the expected signs in the normal regime and TB in the crisis state but they are statistically insignificant. Finally, the coefficients on ΔDM$ are both statistically insignificant and theoretically inconsistent in both states.

Results in Table 8 provide evidence of significant two-month-lagged effects of the inflation differential (ΔINFD) on the probability of transition from the normal state, p_{nn}. The fact that the parameter estimates for current ΔINFD -by contrast to one-month and two-lagged ΔINFD- are not significantly different from zero suggests that there is at least one month between the improvement in the inflation differential and its beneficial effect on foreign exchange market. Figure 4h plots p_{nn} for two-month-lagged ΔINFD. The plot is almost identical to that of Figure 4h (for one-month-lagged ΔINFD) and therefore has the same implications (the trigger value of ΔINFD is slightly larger than for one-month-lagged ΔINFD and is equal to 0.982 percent). The coefficients on ΔRERD take the expected sign in both states but are not statistically significant. Likewise, DEBTD in the normal state as well as ΔINFD, IPD and M2R/D in the crisis state display the correct signs but are statistically insignificant. Finally, IPD and M2/RD are significant in the normal state but the signs of the coefficients are not as one would anticipate.

In principle, changing the specification of the transition probabilities should alter the classification of the observations between normal and crisis periods. In practice, the dating of currency crises obtained with the TVTP model differs slightly from that of the FTP model for the different explanatory variable(s). This statement is confirmed by relatively close values of the TP-statistics in Tables 1f and 2 to 8 and implies that a significant part of the specification is the dependence from past states but there remains some leeway for the various indicators to influence the dating of the crises.

[28] The trigger value of two-month lagged ΔUR is 0.32 percent.

Table 3: Z_t = Current French Variables and External Variable

	DEBT	ΔINF	ΔIP	ΔRER	TB	M2/R	ΔUR	ΔGDP	ΔDM$
μ_n	-.1152 [-1.046]	-.0879 [-.793]	-.0812 [-.667]	-.0915 [-.791]	-.1272 [-1.068]	-.0973 [-.819]	-.0945 [-.821]	-.0768 [-.605]	-.1218 [-1.14]
μ_c	1.4589* [2.965]	1.186* [2.429]	1.2183* [2.569]	1.3610* [2.720]	1.4213* [2.930]	1.4184* [2.978]	1.3579* [3.302]	1.2121* [2.412]	1.450* [2.96]
ρ_n	.2368* [2.983]	.2342* [2.785]	.2394* [2.854]	.2435* [2.921]	.2292* [3.01]	.2484* [3.108]	.2583* [3.218]	.2400* [2.878]	.2352* [3.04]
σ_n^2	1.2491* [7.514]	1.1406* [6.705]	1.1713* [6.618]	1.1855* [7.038]	1.2265* [7.563]	1.2380* [6.696]	1.1917* [7.225]	1.1709* [6.441]	1.162* [7.01]
σ_c^2	8.4938* [4.516]	8.3726* [4.681]	8.4241* [4.942]	8.7843* [4.394]	8.3089* [4.563]	8.6637* [4.476]	8.5755* [4.683]	8.4757* [4.411]	8.585* [4.68]
δ_n^0	3.664** [1.968]	2.6207* [4.477]	2.6214* [4.885]	2.4957* [4.651]	1.9683* [3.219]	3.323* [2.049]	2.2985* [4.738]	2.6344* [4.919]	2.472* [5.45]
δ_n^1	-3.8929 [-.588]	-.9776 [-.459]	.4855 [1.022]	-.1061 [-.801]	-17.95 [-1.604]	-.6810 [-.400]	.5930 [.957]	8.8677 [.904]	.0413 [.232]
δ_c^0	3.493** [1.686]	1.638** [1.711]	1.4429* [1.968]	.9342 [1.521]	.0815 [.068]	4.8252 [1.501]	-.6603 [-.668]	1.474** [1.927]	1.425* [2.24]
δ_c^1	-9.4961 [-1.201]	-3.1403 [-1.103]	-.7874 [-.965]	.1501 [.889]	-20.35** [-1.726]	-3.6139 [-1.187]	3.0382* [2.256]	-14.843 [-.927]	.4131* [2.47]
Lik.	-198.1	-198.2	-198.0	-197.6	-196.9	-198.1	-195.2	-198.3	-195.8
MSE	3.2565	3.3108	3.2709	3.2738	3.3134	3.2547	3.3301	3.2761	3.2694
TP	.1449	.1495	.1393	.1301	.1661	.1318	.1592	.1392	.1270

Table 4: Z_t = Current Differences in the French and German Variables

	DEBTD	ΔINFD	IPD	ΔRERD	TBD	M2/RD	ΔURD	ΔGDPD
μ_n	-.1120 [-.944]	-.0872 [-.834]	-.0856 [-.746]	-.1089 [-1.008]	-.0779 [-.705]	-.0940 [-.684]	-.0874 [-.783]	-.0864 [-.687]
μ_c	1.4310* [2.723]	1.1813* [2.548]	1.3237* [2.553]	1.4014* [3.179]	1.2941* [2.532]	1.3589* [2.614]	1.2927* [2.479]	1.3118* [2.664]
ρ_n	.2377* [2.928]	.2481* [3.004]	.2435* [2.972]	.2170* [3.109]	.2447* [3.015]	.2411* [2.949]	.2537* [3.064]	.2440* [2.951]
σ_n^2	1.2330* [6.711]	1.1562* [7.850]	1.1984* [6.747]	1.2736* [8.541]	1.1995* [6.570]	1.2082* [6.753]	1.1569* [6.055]	1.1923* [6.711]
σ_c^2	8.5082* [4.383]	8.4143* [4.703]	8.7253* [4.481]	8.2712* [4.783]	8.7466* [4.745]	8.6700* [4.131]	8.6912* [4.790]	8.6821* [4.491]
δ_n^0	2.7294* [3.445]	2.9949* [3.846]	2.6499* [4.979]	4.9067* [2.996]	2.9206* [2.266]	3.4716 [1.050]	2.2814* [3.871]	2.6337* [4.874]
δ_n^1	-.6052 [-.259]	-3.4934 [-1.139]	.1290 [.473]	2.216** [1.779]	1.6137 [.295]	.8356 [.258]	.8296 [1.238]	3.009 [.486]
δ_c^0	1.359** [1.670]	1.4278* [2.473]	1.2795* [2.039]	3.1961* [2.650]	1.8201 [1.333]	.9272 [.3126]	.6240 [.932]	1.2844* [1.978]
δ_c^1	-1.7744 [-.883]	-.4604 [-.409]	-.1445 [-.307]	1.1932* [2.245]	3.089* [.513]	-.3306 [-.100]	-.6584 [-.866]	-3.7534 [-.333]
Lik.	-198.3	-198.4	-198.8	-194.1	-198.8	-198.7	-196.5	-198.8
MSE	3.2520	3.2623	3.2771	3.2188	3.2929	3.2721	3.3289	3.2862
TP	.1414	.1480	.1324	.1646	.1301	.1326	.1351	-.1329

Table 5: Z_t = Lagged French Variables and External Variable (1 lag)

	DEBT	ΔINF	ΔIP	ΔRER	TB	M2/R	ΔUR	ΔGDP	ΔDM$
μ_n	-.1145 [-.976]	-.0859 [-.774]	-.1202 [-1.127]	-.0900 [-.829]	-.1239 [-1.125]	-.0959 [-.823]	-.0873 [-.766]	-.1061 [-.941]	-.1199 [-1.12]
μ_c	1.4539* [2.899]	1.2689* [2.578]	1.5175* [2.754]	1.6771* [2.851]	1.3987* [3.1913]	1.3795* [2.842]	1.3401* [2.957]	1.5026* [2.797]	1.455* [2.97]
ρ_n	.2206* [2.525]	.2296* [2.530]	.2033* [2.202]	.2298* [2.734]	.2208* [2.573]	.2342* [2.623]	.2469* [2.744]	.2049* [2.265]	.236* [3.04]
σ_n^2	1.2471* [7.023]	1.162* [6.540]	1.2230* [6.442]	1.2821* [7.928]	1.2288* [7.382]	1.2151* [6.617]	1.1831* [6.980]	1.2001* [6.867]	1.172* [7.04]
σ_c^2	8.4216* [4.687]	8.5562* [4.643]	8.8527* [4.292]	9.5467* [4.319]	8.1873* [4.419]	8.5833* [4.466]	8.5851* [4.611]	8.8488* [4.277]	8.596* [4.68]
δ_n^0	3.624** [1.679]	2.4651* [4.858]	2.6582* [4.615]	2.7856* [4.615]	2.1467* [4.257]	3.2615* [2.030]	2.2035* [4.511]	2.6031* [4.658]	2.467* [5.43]
δ_n^1	-3.9125 [-.498]	-.7751 [-.282]	.7952* [1.994]	-1.1031 [-1.524]	-12.778 [-1.586]	-.7099 [-.409]	.7679 [1.155]	14.577* [2.130]	.0401 [.226]
δ_c^0	3.4748 [1.538]	1.1921* [1.979]	.8466 [1.372]	1.2100 [1.289]	.1649 [.195]	4.927** [1.747]	-.8887 [-.853]	.8919 [1.349]	1.423* [2.24]
δ_c^1	-9.5899 [-1.077]	-.5406 [-.250]	-.4569 [-.628]	2.0295 [1.055]	-27.9** [-1.771]	-3.7952 [-1.376]	3.4136* [2.328]	-11.468 [-.752]	.4132* [2.46]
Lik.	-197.6	-198.3	-198.0	-195.9	-196.2	-197.3	-194.4	-196.6	-195.6
MSE	3.2559	3.2641	3.3723	3.3671	3.3192	3.2480	3.3349	3.3787	3.2852
TP	.1559	.1490	.1459	.1470	.1743	.1462	.1811	.1465	.1273

Table 6: Z_t=Lagged Differences Between the French and German Variables (1 lag)

	DEBTD	ΔINFD	IPD	ΔRERD	TBD	M2/RD	ΔURD	ΔGDPD
μ_n	-.1123 [-.891]	-.0362 [-.339]	-.083 [-.719]	-.0897 [-.753]	-.0751 [-.653]	-.0624 [-.514]	-.0825 [-.730]	-.1049 [-.947]
μ_c	1.4465* [2.814]	1.2853* [2.587]	1.3307* [2.549]	1.3683* [2.823]	1.2855* [2.591]	1.1291* [2.686]	1.3137* [2.522]	1.3966* [2.735]
ρ_n	.2381* [2.951]	.2335* [2.899]	.2443* [2.918]	.2441* [2.963]	.2270* [2.469]	.2191* [2.635]	.2371* [2.622]	.2195* [2.393]
σ_n^2	1.281* [6.328]	1.1988* [7.438]	1.2101* [6.853]	1.1969* [7.165]	1.1877* [6.590]	1.2131* [7.301]	1.1668* [6.307]	1.1945* [6.692]
σ_c^2	8.4989* [4.553]	9.5919* [4.592]	8.7456* [4.449]	8.7972* [4.312]	8.7413* [4.591]	8.1249* [4.913]	8.7544* [4.341]	8.5609* [4.493]
δ_n^0	2.7609* [3.772]	3.1734* [4.603]	2.6459* [4.988]	2.4925* [4.843]	2.7834* [2.448]	4.0252* [3.532]	2.2713* [4.013]	2.5819* [4.815]
δ_n^1	-.7951 [-.346]	-4.282* [-2.431]	.1306 [.491]	-.1030 [-.714]	1.2171 [.247]	1.578** [1.949]	.7918 [1.196]	3.3818 [.582]
δ_c^0	1.371** [1.895]	1.1005* [2.127]	1.2748* [2.016]	.9287 [1.536]	2.175** [1.681]	2.3126* [2.189]	.6525 [.959]	1.305** [1.844]
δ_c^1	-1.8989 [-.915]	.5511 [.511]	-.1478 [-.313]	.1515 [.851]	4.9914 [.836]	.7656 [1.527]	-.5890 [-.8425]	8.4191 [.928]
Lik.	-198.1	-194.8	-198.6	-197.5	-198.0	-195.9	-196.3	-197.9
MSE	3.2796	3.3909	3.2871	3.3027	3.2923	3.4033	3.3262	3.2628
TP	.1429	.1454	.1325	.1303	.1478	.1759	.1513	.1484

Table 7: Z_t = Lagged French Variables and External Variable (2 lags)

	DEBT	ΔINF	ΔIP	ΔRER	TB	M2/R	ΔUR	ΔGDP	ΔDM$
μ_n	-.1315 [-1.126]	-.0973 [-.874]	-.0985 [-.883]	-.0969 [-.852]	-.1252 [-1.099]	-.1060 [-.952]	-.1017 [-.881]	-1009 [-.873]	-.1044 [-.931]
μ_c	1.4464* [3.109]	1.2769* [2.791]	1.2521* [2.672]	1.2940* [2.569]	1.3154* [2.743]	1.3137* [2.743]	1.3496* [2.851]	1.2679* [2.576]	1.317* [2.62]
ρ_n	.2399* [2.777]	.2635* [2.887]	.2453* [2.839]	.2444* [2.709]	.2513* [2.833]	.2571* [3.416]	.2697* [3.029]	.2465* [2.704]	.2481* [2.74]
σ_n^2	1.2269* [7.378]	1.1422* [6.941]	1.1319* [6.371]	1.1579* [7.664]	1.2105* [6.936]	1.1723* [6.859]	1.1519* [7.072]	1.1414* [6.254]	1.173* [6.66]
σ_c^2	8.3930* [4.695]	8.6289* [4.747]	8.5367* [4.525]	8.6806* [4.479]	8.2204* [4.639]	8.5249* [4.619]	8.6745* [4.623]	8.5328* [4.761]	8.573* [4.54]
δ_n^0	3.674** [1.782]	2.5186* [4.743]	2.5567* [5.126]	2.5171* [4.938]	2.1342* [4.020]	3.3061* [2.015]	2.1601* [4.797]	2.5710* [4.894]	2.539* [4.71]
δ_n^1	-4.078 [-.551]	-2.0343 [-1.194]	-.0879 [-.201]	-.1229 [-.841]	-14.546 [-1.332]	-.7972 [-.460]	.8015 [1.263]	-3.3911 [-.313]	-.0436 [-.26]
δ_c^0	3.679** [1.738]	1.168** [1.885]	1.4499* [2.318]	1.133** [1.797]	.4343 [.463]	3.8877 [1.502]	-1.2840 [-1.090]	1.3559* [2.073]	1.229* [2.03]
δ_c^1	-10.37 [-1.226]	.4737 [.257]	.4694 [.904]	.0318 [.204]	-15.820 [-1.181]	-2.789 [-1.074]	4.0522* [2.507]	6.3493 [.606]	.1047 [.525]
Lik.	-195.8	-196.1	-196.5	-196.2	-195.88	-196.2	-191.9	-196.6	-196.6
MSE	3.2604	3.2698	3.2765	3.2808	3.3687	3.2584	3.3484	3.2768	3.2699
TP	.1687	.1664	.1728	.1639	.1699	.1697	.1995	.1691	.1669

Table 8: Z_t=Lagged Differences Between the French and German Variables (2 lags)

	DEBTD	ΔINFD	IPD	ΔRERD	TBD	M2/RD	ΔURD	ΔGDPD
μ_n	-.1349 [-1.151]	-.0729 [-.627]	-.1603 [-1.219]	-.1109 [-1.022]	-.0906 [-.765]	-.1333 [-1.205]	-1014 [-.861]	-.2323* [-2.059]
μ_c	1.4293* [3.022]	1.3697* [2.778]	1.5501* [2.689]	1.5101* [2.789]	1.2650* [2.606]	1.3723* [2.821]	1.2829* [2.553]	1.7001* [4.171]
ρ_n	.2406* [2.850]	.2635* [3.029]	.2465* [2.668]	.2373* [2.698]	.2591* [2.854]	.2275* [2.618]	.2570* [2.766]	.2262* [2.345]
σ_n^2	1.2209* [7.213]	1.1748* [7.312]	1.2174* [6.481]	1.2051* [7.556]	1.1576* [6.671]	1.2163* [6.929]	1.1314* [6.199]	1.2969* [8.196]
σ_c^2	8.3104* [4.845]	9.3437* [4.351]	8.2658* [4.506]	9.0682* [4.177]	8.6962* [4.725]	8.1852* [4.676]	8.6179* [4.421]	7.1064* [4.711]
δ_n^0	2.8762* [3.544]	2.5974* [4.870]	2.5942* [4.643]	2.5638* [5.436]	1.955** [1.850]	6.8445* [2.712]	2.2756* [4.299]	2.9726* [3.766]
δ_n^1	-1.3845 [-.489]	-2.643* [-2.371]	-.3238* [.882]	-.7538 [-1.462]	-3.2068 [-.622]	3.799** [1.773]	.5728 [.936]	-20.3** [-1.744]
δ_c^0	1.469** [1.856]	.8585 [1.410]	1.3926 [1.513]	.9371 [1.465]	1.8289 [1.517]	3.857** [1.939]	.7858 [1.235]	4.1168 [1.123]
δ_c^1	-2.4156 [-1.069]	.5521 [.554]	-.6726 [-.844]	.12287 [.425]	3.2272 [.627]	2.3563 [1.226]	-.5013 [-.791]	-127.5 [-1.10]
Lik.	-196.0	-194.3	-196.5	-196.0	-196.1	-196.2	-195.4	-194.7
MSE	3.2598	3.3536	3.2408	3.2769	3.3149	3.2730	3.3209	3.1398
TP	.1698	.1557	.1641	.1578	.1655	.1662	.1686	.1897

Figure 4a: p_{cc} TB_t

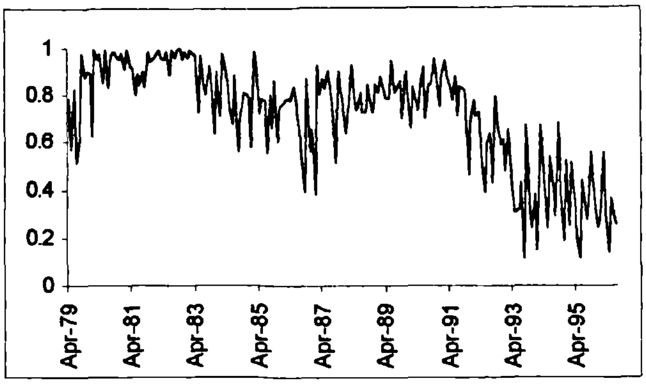


Figure 4b: p_{cc} ΔUR_t

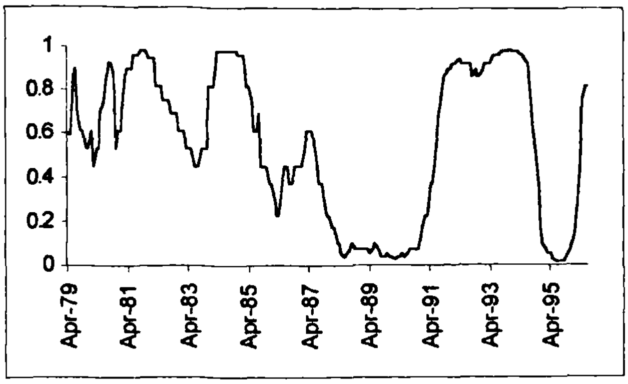


Figure 4c: p_{cc} $\Delta RERD_t$

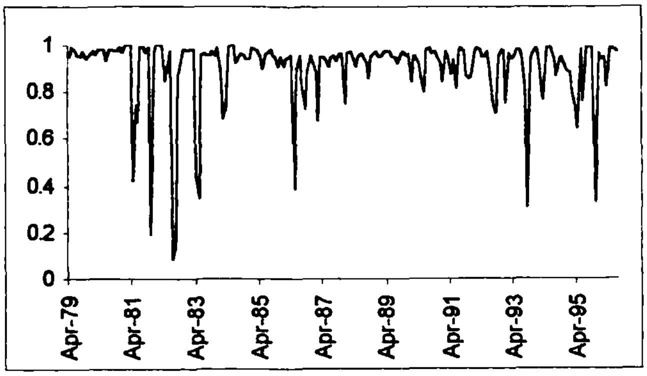


Figure 4d: p_{nn} ΔIP_{t-1}

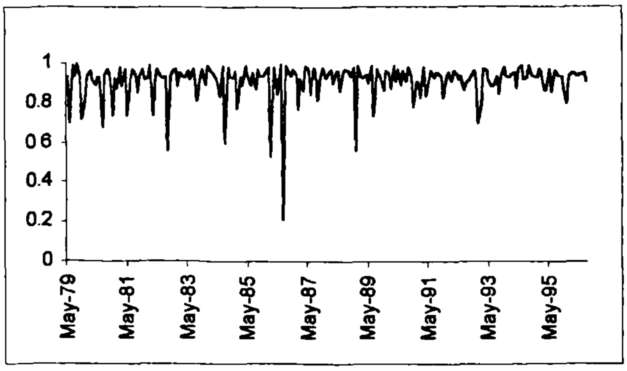


Figure 4e: p_{cc} TB_{t-1}

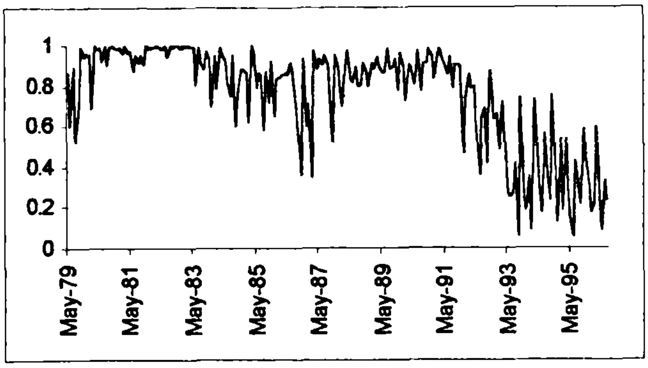


Figure 4f: p_{cc} ΔUR_{t-1}

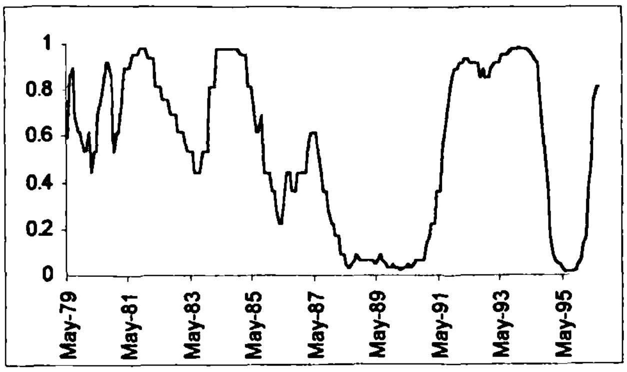


Figure 4g: p_{nn} ΔGDP_{t-1}

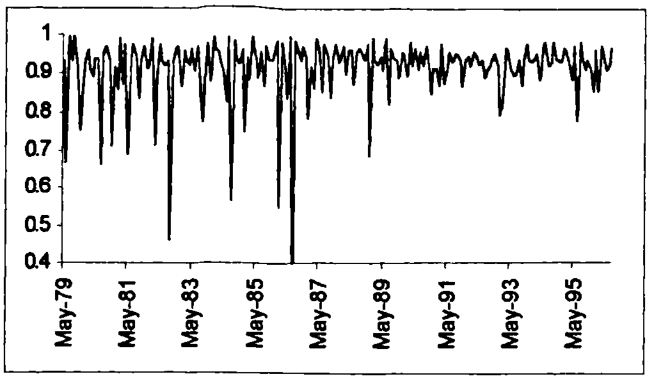


Figure 4h: p_{nn} $\Delta INFD_{t-1}$

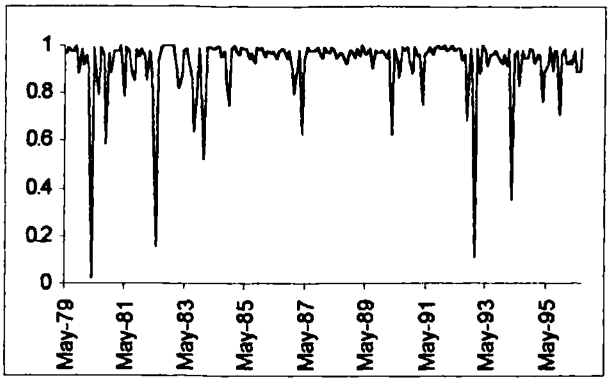


Figure 4i: p_{cc} ΔUR_{t-2}

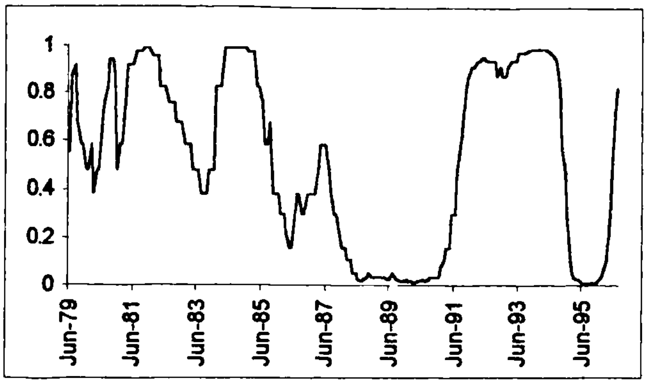
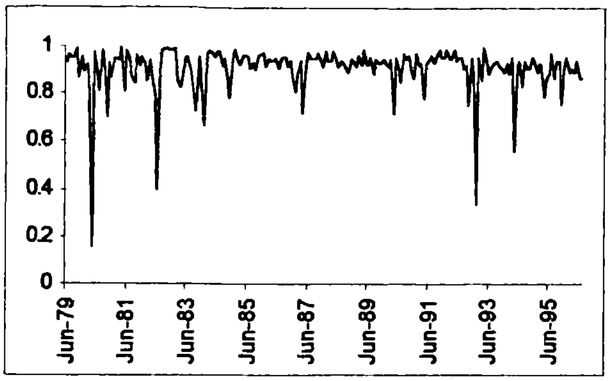


Figure 4j: p_{nn} $\Delta INFD_{t-2}$



5. 4. 3. Conclusions on the French Franc

Results have showed that some economic fundamentals exert a meaningful influence on the French index of EMP. Interestingly enough, the channels through which the significant variables affect switches from the two states are not symmetrical in the sense that most variables are relevant to one state but not the other.

In light of the evidence, it is clear that unemployment plays an important role in the French currency crises. Speculative pressure is more durable when the unemployment rate increases in the current period, in the previous month and two months ago. Another important variable is the trade balance. Indeed, a deteriorating trade balance both in the current period and in the previous month appears to prolong a crisis. Finally, the current differential change between the French and German real exchange rate also affects the transitions of the EMP index from the crisis state. Note that, as documented by Krugman (1996), France showed little change in its real exchange rate vis-à-vis Germany in the period 1988-1995 so that it is not surprising that the real exchange rate only play a minor role in explaining transitions from either state.

GDP growth and industrial production growth, in the previous month only, have a significant impact on the EMP index shifts from the normal state. The fact that ΔGDP and ΔIP are significant only in the previous month signals that it may take a month for output growth to translate into more jobs and a better economy. Finally, transitions of the index of EMP from the normal state are also determined by one-month-lagged and two-month-lagged inflation differentials between France and Germany.

The evidence presented above therefore confirms certain conclusions of the most related studies on the French franc. For example, Jeanne (1997), Okter & Pazarbasioglu (1997) and Jeanne & Masson (1998) also find that unemployment is a consistent and significant variable in generating speculative attacks. Likewise, the trade balance takes the expected sign and is statistically significant in Jeanne & Masson (1998) (though it is not in Jeanne (1997)). Finally, in line with our results speculative pressure is associated with the real exchange rate in Jeanne (1997), Okter & Pazarbasioglu (1997) and Jeanne & Masson (1998).

Finally, the results of this chapter suggest that two economic fundamentals -the debt to GDP ratio and the ratio of money aggregate M2 to reserves- as well as the German mark depreciation rate against the dollar do not play any role in the analysis of EMP on the franc.

5. 5. Results for the Italian Lira

Figure 5 plots the index of EMP for the Italian lira over the period March 1979-December 1996[29]. The graph depicts a stationary series subject to occasional sharp increases until 1992 and to greater volatility thereafter.

5. 5. 1. Estimation of the Markov Regime Switching Model with Fixed Transition Probabilities (Selection of the model and Identification of the Two Regimes)

Table 9a presents the results for the FTP static model. All coefficients are statistically significant. The normal state is associated with a small positive mean and a low variance. The normal regime thus describes a situation in which there is an insignificant depreciation of the domestic currency and/or slightly rising interest rate differentials with Germany and/or minor losses of domestic reserves of foreign exchange.

The crisis state, on the other hand, appears to be depicted by situations where the index takes a larger positive mean value, and a much higher variance. In this respect, a crisis is identified as a situation where there is pressure on the domestic currency, synonymous with a depreciation, and/or increasing interest rate differentials and/or a loss of domestic reserves.

For the static model, the White test reported in Table 9b rejects the null hypothesis of no serial correlation at the 5 percent significance level. Having said that, the LM tests indicate the presence of autoregression in state *n* only. The White and LM tests suggest that there is no significant ARCH effect and the hypothesis that the state follows a Markov chain is not rejected. Andrews' test for a permanent shift in the mean, plotted on Figure 6, displays no evidence of a permanent shift in the means.

As far as the TP statistic reported in Table 9a is concerned, the comparison with the historical fraction of crisis periods, $\overline{TP}$ = 0.08134, based on Table 10, suggests that the model is forecasting more turning points in-sample. Indeed, the model suggests that the

[29] The weights for the domestic currency depreciation rate, change in interest rate differentials and the change in domestic reserves of foreign exchange are 0.40, 0.16 and 0.44, respectively.

lira experienced speculative pressure 13.36 percent of the time whilst it was thought that it actually came under pressure 8.13 percent of the time. A plausible explanation is that the lira was dropped from the ERM in September 1992 and was more volatile thereafter, as suggested by the high smoothed probabilities of being in the crisis state in the early 1990s in Figure 7.

Table 9c gives the results of the estimation of a dynamic AR(1) model where the autoregressive coefficient is constant across states[30]. The autoregressive parameter is statistically significant and the Box-Pierce Q-statistics in Table 9d show that the AR(1) model does not suffer problems of autocorrelation or ARCH.

However, because the static model shows a problem of autocorrelation in state n only, an autoregressive model is estimated that allows for the autoregressive terms to vary across states. Results in Table 9e indicate that the autoregressive term is significant for state n but not for state c. Therefore, a Markov Regime Switching model that allows for autoregression in state n only is estimated.

Results in Table 9f reveal that the latter model fits the data better. The specification with TP=0.0969 does better than the models in Tables 9a, 9c and 9d although it still identifies more crises than one would expect. Additionally, the Mean Squared Error for the output forecast derived from the model in Table 9f (MSE=0.4558) is smaller than that of the other models, and its Schwarz Criterion is the highest (SC=46.68). Therefore, the model adopted for all further estimations with TVTP is that reported in Table 9f.

The normal state of the lira EMP index is therefore depicted by a small positive mean and a small variance. This suggests that, even in tranquil episodes, the lira was under strain, which is in contrast to the French results where the index takes a negative value in the normal regime. The Italian crisis state has a larger positive mean and a much larger variance than the normal regime, depicting its instability. Besides, as in the case of the French index, the normal state follows a first order autoregressive process whilst

[30] Note that larger orders were tried for the regressive terms but did not prove significant.

the crisis state does not. As one would anticipate, the chosen model confirms that periods of stability last longer than turbulent periods. The duration of the normal state, D_n, is given by $D_n = 1/(1 - p_{nn})$=15 months; whilst the crisis state lasts 3.5 months.

Figure 7 plots the unconditional smoothed probabilities that the index was in a state of crisis (or high speculative pressure) at each date in the sample. A crisis month is characterised by a smoothed probability of being in the crisis regime greater than 0.5[31]. Examining Figure 7, various isolated short periods of high pressure are detected by the model. The model infers that the lira was likely to be in the crisis state in March & April 81; October & November 81; March 83; July & August 85; January 87; September 92 until March 93; May until September 93; March & April 94; March until May 95 and August till November 95.

Table 10 compares the crisis months thereby identified and the known exchange rate crises for the Italian lira. In fact, identified crises reported in the first column of Table 10 correspond relatively precisely to months in which either a realignment took place or speculative pressure against the lira was reported to be intensive (column 2 of Table 10). Note that, as in the case of the franc, not all realignments are identified as crisis periods.

Table 9a: Static Model

μ_n	μ_c	σ_n^2	σ_c^2	p_{nn} (%)	p_{cc} (%)	Lik./SC	M.S.E.	T.P.
.0801*	.3689*	.0776*	1.5679*	93.74*	80.93*	50.82	.4878	.1336
[3.129]	[2.069]	[6.467]	[4.424]	[37.19]	[10.95	34.79		

t-statistics are in squared parentheses and (*) denotes significance at the 5 percent level.

Table 9b: Specification Tests for the Static Model

White test F(4, 203)		**LM Tests** F(1, 204)	
Serial Correlation in both regimes	5.944*	Serial Correlation in regime n	22.14*
ARCH effects in both regimes	0.907	Serial Correlation in regime c	3.718
Markov Specification	0.778	Serial Correlation across regimes	24.567*
		ARCH effects in both regimes	1.169

The 5 percent critical values for the F(4, 203) and F(1, 204) are 3 32 and 6.63 respectively; and the 1 percent critical values are 2.37 and 3.92 respectively. (*) denotes significance at the 1 percent level.

[31] Since the estimated probabilities take values close to zero or one, the classification of currency episodes does not change significantly if one chooses a higher threshold.

Table 9c: AR(1) with ρ Constant Across States

μ_n	μ_c	ρ	σ_n^2	σ_c^2	p_{nn}(%)	p_{cc}(%)	Lik./SC	MSE	TP
.069**	.9339*	.4408*	.0678*	1.736*	93.86*	76.71*	65.06	.4726	.1766
[1.777]	[3.939]	[6.689]	[6.918]	[4.239]	[43.25]	[10.07]	46.35		

t-statistics are in squared parentheses and (*) denotes significance at the 5 percent level.

Table 9d: Box-Pierce Q-statistics on residuals for Autocorrelation (A) and Heteroskedasticity (H)

	Q(1)	Q(2)	Q(3)	Q(4)	Q(5)	Q(6)	Q(7)	Q(8)	Q(9)	Q(10)	Q(20)
A	.8552	4.163	9.39*	9.61*	9.679	11.35	11.55	14.81	14.85	15.09	20.40
	[.355]	[.125]	[.025]	[.047]	[.085]	[.078]	[.116]	[.063]	[.095]	[.129]	[.433]
H	.0427	1.186	1.544	1.789	1.823	1.895	1.951	2.429	2.800	2.901	4.281
	[.836]	[.552]	[.672]	[.775]	[.873]	[.929]	[.962]	[.965]	[.972]	[.984]	[.999]

$\chi^2(m)$ tests. *p*-values in square brackets. * denotes significance at the 5 percent level

Table 9e: AR(1) Model with ρ Dependent on State

μ_n	μ_c	ρ_n	ρ_c	σ_n^2	σ_c^2	p_{nn}(%)	p_{cc}(%)	Lik./SC	MSE	TP
.044	.5333*	.527*	.1165	.076*	1.74*	93.28*	71.05*	66.1	.4958	.0978
[1.57]	[2.27]	[6.12]	[.947]	[6.99]	[4.17]	[20.1]	[17.8]	44.71		

All numbers in square parentheses are *t*-statistics. (*) denotes significance at the 5 percent level.

Table 9f: AR(1) Process in State n only

μ_n	μ_c	ρ_n	σ_n^2	σ_c^2	p_{nn}(%)	p_{cc}(%)	Lik./SC	MSE	TP
.068	.5564*	.5463*	.0778*	1.826*	93.44*	69.93*	65.38	.4558	.0969
[1.52]	[2.577]	[7.268]	[7.481]	[4.165]	[220.5]	[19.59]	46.68		

All numbers in square parentheses are *t*-statistics. (*) denotes significance at the 5 percent level.

Figure 5: Italian Index of Exchange Market Pressure

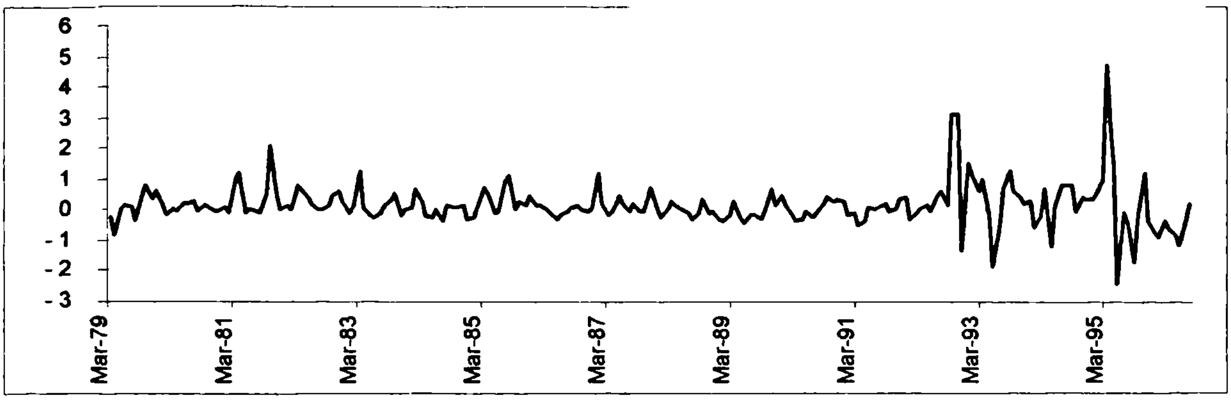


Figure 6: Andrews Test for Permanent Shift in the Mean

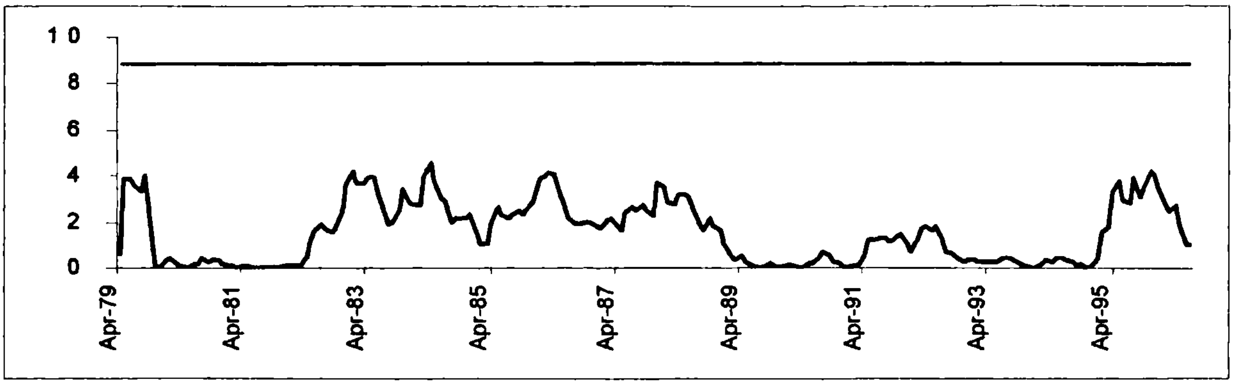


Figure 7: Smoothed Probabilities of Being in the Crisis State

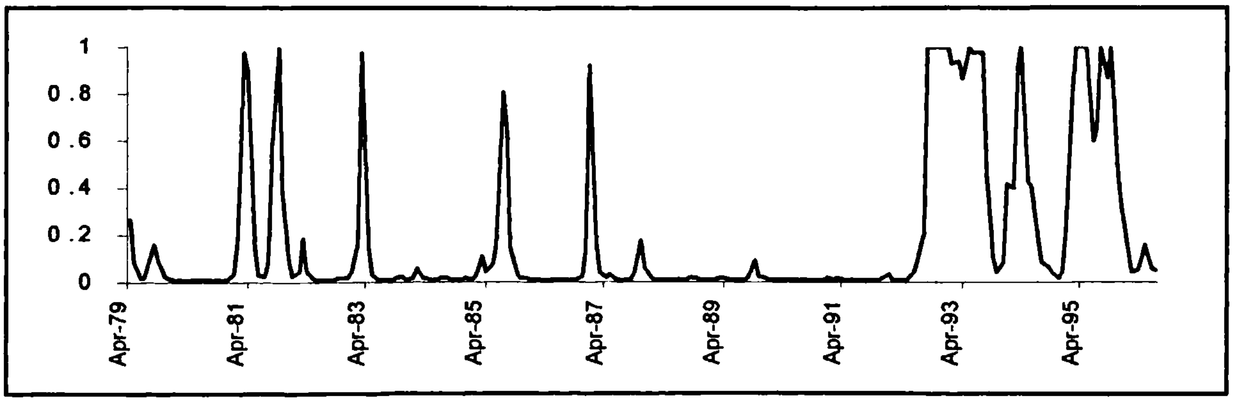


Table 10: The Italian Crises

Model Inference	History
	Sept. 79: DEM revaluation by 2% against all other currencies.
March & April 81	*March 81*: Third ERM realignment (ITL: +6% against the DEM). The four-party coalition government of Forlani that had taken office in Oct.80 resigns on 26/05/81. Formation of a new coalition government under a Republican Prime Minister.
Oct & Nov. 81	*Oct. 81*: Fourth ERM realignment. Largest bilateral change yet seen in the ERM (the ITL is devalued by 3% and the DEM revalued by 5%).
	June 82: Sixth realignment (the DEM and NLG are revalued and the FRF and ITL are devalued). The ITL is effectively devalued by 7%.
March 83	*March 83*: Seventh realignment (the ITL/DEM exchange rate is adjusted by 8%). General realignment.
July & Aug. 85	*July 85*: Eighth realignment (the ITL is devalued by 8% against all other currencies). The trade balance deficit in the first five month of 1985 runs to ITL 14,500,000m, twice that for the same period in 1984. The government has already come under criticism for failing to tackle the economic situation, when in July a sudden fall in the value of the ITL precipitates a devaluation. The Bank of Italy orders the suspension of trading in ITL before the scheduled close

	of financial markets on 19/07/85, after a 17.7 % fall of ITL against the USD.
	Dec. 85: Renewed tensions on the ERM emerge. The pressure requires intervention by the authorities as outflows from the USD go into the DEM.
	April 86: Ninth realignment. The lira and the franc are devalued against all other currencies (by 3% for the lira)
Jan. 87	*Jan. 87*: Eleventh Realignment. Foreign exchange markets are in turmoil as the dollar resumed its rapid fall at the end of 1986. Ex-post, the eleventh realignment is perceived as being provoked more by speculative unrest in currency markets then by macroeconomic divergence among the participants (which was the case for the previous ten realignments). The Bundesbank actually operates its largest ERM intervention in the period 1986-87.
Sept. 92 – March 93	*Spring 1992*: Short-term interest rates firm again pushed by the threat of another large overshoot of the budget deficit. In July the ITL comes under heavy speculative pressure forcing the monetary authorities to lift the discount rate to record levels. Continued losses of reserves (over the 15-months period to Aug. 92 Italy loses more than a third of its international reserves) prompt the Bank of Italy to raise interest rates even more in early Sept., despite which pressure on the ITL persists. There follows a 7 percent official ITL devaluation and shortly after a suspension of the ITL from the ERM *Feb. 93*: The government comes to a close collapse as the repercussions of a corruption scandal leads to increasing numbers of arrests and resignations in the political and institutional establishment. Andreatti replaces Reviglio as Budget Minister. The return to relative calm in foreign exchange markets after the 1992 crisis is only transient. *From Jan. to April 93*: Growing apprehensions about Italy's political and economic future push the ITL to historic lows against all major currencies, implying considerable real undervaluation. *March 1993*: Policy moves to steer interest rates down are suspended when fears of renewed fiscal slippage and political instability send the exchange rate to new record lows.
May – Sept. 93	*Aug. 93*: The ERM fluctuation band is widened drastically following intensive pressure against most ERM currencies and the ITL begins losing ground again.
	Aug. 94: Continuing political uncertainties result in increasing pressure on the ITL which crossed the symbolic barrier of DEM1=ITL 1,000 in July. On 11/08/94, the Bank of Italy raises the discount rate by 0.5% (first rise since 09/92) in a move to end speculative activity and avoid a build-up of inflationary tensions. However, the following day the ITL falls in value to a record low against the DEM. *Dec. 94*: Fall of Berlusconi who resigns after losing support from the Northern League and faces animosity with the president. Growing political uncertainty threatens the stability of the ITL that falls to a new record low against the DEM.
March – May 95	*Jan. 95*: The Bank of Italy is obliged to intervene on foreign exchange markets to support the ITL on several occasions - the first time it does so since the ITL has left the ERM. Feb. 95: The Bank of Italy raises the discount interest rate by 0.75 percentage points. *May 95*: The Bank of Italy raises the discount rate and Lombard rate by 0.75 percentage points in an attempt to counter inflationary pressure.

Aug. – Nov. 95	No evidence

5. 5. 2. Time-Varying Transition Probabilities: The Role of Economic Fundamentals

Tables 11 to 16 report the results of the estimation of the TVTP version of the Markov Switching model. In all tables the mean in the crisis state, the autoregressive coefficient, the variances and the constant term in p_{nn}, δ_n^0, are statistically significant; whilst δ_c^0 and the mean in the normal state are not always significant. Note that the fact that δ_n^0 is always significant and positive provides strong evidence that the normal state is highly persistent.

Table 11 summarises the findings as to the effects of the Italian current economic variables and German mark depreciation rate on the Italian EMP index. Two variables only are statistically significant and have the correct sign. An increase in the debt to GDP ratio (DEBT) prolongs crisis periods, whilst a fall in the ratio of M2/R raises the probability of remaining in the normal state. Figure 8a plots the probability of staying in the crisis regime, p_{cc}, with DEBT as forcing variable. It appears that debt only starts to have an important impact after the mid-1980s when the transition probability crosses the 0.5 level and increases gradually thereafter. More precisely, p_{cc} is higher than the 0.5 threshold as long as DEBT is above 73.5 percent (Figure I1 of Appendix 4.2 confirms that this is the case after the mid-1980s). Figure 8b plots the probability of staying in the normal regime, p_{nn}, with M2/R as forcing variable. The transition probability remains close to unity throughout the entire sample period (with a small drop in 92M09). Indeed, p_{nn} falls below 0.5 only if M2/R exceeds 1.45 which, according to Figure I6 in Appendix 4.2, never occurs. In other words, this means that M2/R never was high enough so as to trigger a shift from the normal to the crisis state. Some other parameters in Table 11 take the expected signs (ΔRER in both states; DEBT, ΔGDP and ΔDM$ in the normal state and, ΔINF, ΔDM$ and M2/R in the crisis state), but are not statistically significant. Other coefficients are statistically insignificant in both states and do not take the expected sign: for TB and ΔIP.

Table 12 presents the results for current differences between the domestic and German economic variables. The transition probabilities are significantly affected by the debt differential (DEBTD) when EMP is in the crisis state and by the industrial production (IPD) when EMP is in the normal state. Figure 8c plots p_{cc} as a function of DEBTD. Given the similarity between Figures 8c and 8a, the conclusions are the same for current DEBT and DEBTD (the trigger value of DEBTD is 55.1 percent). Figure 8d plots p_{nn} as a function of IPD. The probability is constantly very high until the beginning of 1993 when it starts decreasing and hits its lowest value in 95M05, after which it rises gradually. This suggests that the recession of the early 1990s may have contributed to the lira crises -identified by the unconditional probability of being in the crisis state (Figure 7)- in 1993, 1994 and 1995. The coefficient on M2/RD is also statistically significant in the crisis state but does not display the expected sign. Several variables take the expected sign (DEBTD, M2/RD and ΔGDPD in the normal state as well as ΔINFD and IPD in the crisis state) but are not statistically significant. Finally, TBD and ΔRERD display the wrong signs and are statistically insignificant in both states.

In Table 13, two one-month-lagged Italian economic factors affect regime switches. An increase in the ratio of DEBT to GDP seems to aggravate a crisis (the coefficient is statistically significant and correctly signed). Figure 8e is akin to Figure 8c and 8a and the trigger value of one-month-lagged DEBT (71.8 percent) is similar to that of current DEBT. Also the parameter for M2/R is statistically significant and displays the expected sign in the normal state. Figure 8f resembles Figure 8b and the trigger value of one-month-lagged M2/R, 1.37, is never reached either. DEBT and ΔIP in the normal state, ΔGDP in both states and M2/R in the crisis state display the correct signs but are statistically insignificant. Finally, the coefficients for ΔINF, ΔRER, TB and ΔDM$ are neither statistically significant nor correctly signed.

Table 14 presents the results for one-month-lagged differentials between the Italian and German economic variables. Again, the DEBT differential affects the crisis state significantly and its parameters has the anticipated sign. Figure 8g provides the same inference as Figures 8a, 8c, and 8e and the trigger value is 52.35 percent. The coefficient on INFD also displays the correct sign in the crisis state and is statistically significant at the ten percent level. Figure 8h plots p_{cc} for ΔINFD. The plot depicts an extremely volatile series. However, it can be verified that the transition probability is well above 0.5 in most of the crisis episodes identified by the model (the exceptions are 81M10&11, 92M11 and 93M02&03). In fact, p_{cc} is less than 0.5 as soon as ΔINFD falls below -0.16 percent. Figure I9 in Appendix 4.2 shows that ΔINFD goes below the trigger value very often which explains the volatility of p_{cc}. In Table 14, M2/RD and TBD also have significant coefficients in the crisis state but their signs are not as anticipated. Some variables display the correct signs in the normal state (DEBTD, IPD, ΔRERD and M2R/D) and in the crisis state (ΔGDPD) but are not statistically significant. On the other hand, most other coefficients are not significant and do not take the expected signs (ΔINFD, TBD and ΔGDPD in the normal state; IPD and ΔRERD in the crisis state).

Table 15 reports the results for the two-months lagged Italian economic variables and German mark depreciation rate. Transitions from the normal state are significantly influenced by the two-months lagged M2/R ratio. Figure 8j resembles Figures 8b and 8f and therefore the same conclusions apply (the trigger value, 1.162, is however lower and reached in September 1992). Transitions from the crisis state are significantly explained by the ratio of Debt to GDP and by real GDP growth. When DEBT is higher than 73.85 percent, the index of EMP is more likely to remain in the crisis state than to switch to the normal regime. Conversely, the lower ΔGDP, the higher p_{cc} (a value of ΔGDP below 1.43 percent makes p_{cc} stay above 0.5). An examination of Figure I7 in Appendix 4.2 reveals that ΔGDP exceeds its trigger value on many occasions, which justifies the volatility of p_{cc} in Figure 8k. Indeed, Figure 8k suggests that p_{cc} fluctuates constantly between zero and one until mid 1988, before stabilising between 0.5 and unity (p_{cc} however plummets on a few occasions thereafter: 92M12, 93M04, 93M12, 95M11 and 96M03). As far as other variables in Table 15 are concerned, ΔIP and ΔDM$ affect both states with the correct sign but they are not statistically significant. The coefficients on DEBT and ΔGDP take the correct signs in the normal state but are not statistically significant. Similarly, M2/R takes the expected sign but is statistically insignificant in the crisis state. Finally, ΔRER and ΔINF are both statistically significant in the normal state but their signs do not conform to theoretical intuitions.

Table 16 summarises results of the estimation regarding two-months lagged differences between the Italian and German economic variables. DEBTD is the only theoretically consistent and statistically significant explanatory variables. That is, when DEBTD is lower than 55.5 percent, the index of EMP is more likely to move from the crisis to the normal state. Once again, the plot of the conditional transition probability in Figure 8*l* resembles the corresponding plots for current and one-month-lagged DEBT and DEBTD. IPD and ΔGDPD display the correct signs but are statistically insignificant. In the normal state, DEBTD, ΔRERD and M2R/D all take the expected signs but their coefficients are statistically insignificant. Likewise, INFD is correctly signed but statistically insignificant in the crisis regime, whilst RERD and M2/RD are statistically significant but their sign do not correspond to what one would expect on theoretical grounds.

Table 11: Z_t = **Current Italian Variables and External Variable**

	DEBT	ΔINF	ΔIP	ΔRER	TB	M2/R	ΔGDP	ΔDM$
μ_n	.073** [1.64]	.00692 [1.505]	.0704** [1.691]	.0704** [1.691]	.0654 [1.468]	.0677 [1.483]	.0695 [1.559]	.073** [1.68]
μ_c	.5044* [2.328]	.5636* [2.648]	.5621* [2.453]	.5621* [2.453]	.5312* [2.516]	.5608* [2.611]	.5503* [2.401]	.553* [2.42]
ρ_n	.5347* [6.949]	.5367* [7.143]	.5439* [6.452]	.5439* [6.452]	.5455* [7.972]	.5511* [7.536]	.5421* [6.927]	.547* [7.35]
σ_n^2	.0742* [12.483]	.0793* [15.07]	.0788* [15.24]	.0788* [15.24]	.0735* [13.46]	.0776* [14.52]	.0792* [14.81]	.078* [6.63]
σ_c^2	1.7448* [8.507]	1.8788* [8.459]	1.8287* [9.041]	1.8287* [9.040]	1.7421* [8.228]	1.8374* [8.408]	1.8352* [7.999]	1.837* [3.74]
δ_n^0	2.923** [1.873]	2.7620* [6.814]	2.7918* [6.027]	2.7918* [6.027]	2.2864* [5.134]	3.8179* [4.158]	2.6490* [6.255]	2.74* [6.39]
δ_n^1	-.0069 [-.207]	.5291 [.538]	-.1455 [-.896]	-.1455 [-.896]	-4.5423 [-1.372]	-2.57** [-1.772]	.1271 [1.594]	.124 [.719]
δ_c^0	-3.585 [-1.654]	1.123** [1.838]	.8834** [1.941]	.8834** [1.941]	.7244 [1.479]	-.7584 [-.401]	.9396** [1.918]	1.049* [1.98]
δ_c^1	.0488* [2.107]	4.4706 [1.498]	.0814 [.587]	.0814 [.059]	3.5800 [1.163]	2.7987 [.908]	.0001 [.001]	.1987 [1.28]
Lik.	68.39	67.69	65.59	65.59	67.72	67.94	66.54	.4596
MSE	.4675	.4598	.4577	.4577	.4566	.4560	.4574	.4596
TP	.1116	.1655	.0983	.0983	.1789	.0955	.1002	.0983

Table 12: Z_t = **Current Differences in the Italian and German Variables**

	DEBTD	ΔINFD	IPD	ΔRERD	TBD	M2/RD	ΔGDPD
μ_n	.0731** [1.713]	.0889* [2.047]	.0882* [2.315]	.0672 [1.574]	.0656 [1.479]	.0783* [2.230]	.0679 [1.616]
μ_c	.5020* [2.212]	.5233* [2.221]	.3612* [2.012]	.5630* [2.479]	.5279* [2.403]	.3442* [2.292]	.5492* [2.380]
ρ_n	.5336* [6.862]	.5469* [7.454]	.4263* [4.696]	.5531* [7.662]	.5427* [6.944]	.4137* [5.029]	.5563* [6.995]
σ_n^2	.0739* [12.72]	.0804* [14.71]	.0527* [13.42]	.0780* [13.77]	.0732* [13.108]	.0577* [14.24]	.0763* [14.43]
σ_c^2	1.7408* [8.007]	1.9177* [7.367]	1.5883* [8.423]	1.8466* [8.173]	1.7184* [8.209]	1.3749* [9.554]	1.8007* [8.348]
δ_n^0	2.9241* [2.368]	2.5938* [7.102]	2.4034* [5.891]	2.5919* [6.042]	1.7327* [2.354]	.1444 [.088]	2.5565* [6.487]
δ_n^1	-.0053 [-.273]	.1762 [.204]	.1000** [1.716]	.1091 [.303]	-4.2392 [-1.331]	-1.8876 [-1.453]	.0062 [.221]
δ_c^0	-2.93** [-1.75]	.9498 [1.318]	.4665 [.882]	.6074 [1.017]	1.352** [1.844]	-7.972* [-2.398]	.5255 [1.009]
δ_c^1	.0532* [2.299]	5.9804 [1.631]	-.1010 [-1.335]	-.1046 [-.744]	5.3988 [1.580]	-7.115* [-2.538]	.0520 [1.362]
Lik.	68.59	67.37	68.27	65.82	69.08	70.10	66.22
MSE	.4679	.4669	.4794	.4582	.4552	.4800	.4604
TP	.1124	.0952	.1517	.0951	.1098	.1884	.1034

Table 13: Z_t = Lagged Italian Variables and External Variable (1 lag)

	DEBT	ΔINF	ΔIP	ΔRER	TB	M2/R	ΔGDP	ΔDM$
μ_n	.0945* [2.639]	.0720** [1.872]	.0779 [1.603]	.0905* [2.602]	.0736** [1.850]	.0724** [1.753]	.0786** [1.694]	.072** [1.84]
μ_c	.3668* [2.098]	.5380* [2.580]	.5597* [2.351]	.3872* [2.109]	.5497* [2.544]	.5696* [2.598]	.5743* [2.392]	.571* [2.59]
ρ_n	.3969* [4.592]	.5206* [6.456]	.5329* [7.144]	.3986* [4.872]	.5268* [6.480]	.5337* [6.587]	.5280* [7.141]	.5298* [7.01]
σ_n^2	.0627* [13.08]	.0745* [15.21]	.0788* [15.00]	.0629* [13.89]	.0748* [15.06]	.0758* [14.58]	.0789* [15.17]	.0761* [14.7]
σ_c^2	1.5632* [8.576]	1.7926* [8.007]	1.8390* [7.911]	1.6189* [9.099]	1.7697* [7.879]	1.8160* [7.459]	1.8813* [7.655]	1.817* [7.99]
δ_n^0	2.8583 [1.611]	3.2385* [5.858]	2.8588* [6.393]	2.5212* [6.415]	2.4859* [5.317]	4.1104* [3.876]	2.6802* [6.344]	2.719* [7.73]
δ_n^1	-.0023 [-.104]	2.2019* [2.366]	.1719 [1.225]	.1176 [2.125]	-2.6181 [-.779]	-3.00** [-1.698]	.1276 [1.432]	-.010 [-.082]
δ_c^0	-4.773* [-2.117]	1.0932* [2.234]	.9125** [1.903]	.6992 [1.448]	.8685** [1.765]	.1292 [.101]	.9072** [1.806]	1.08** [1.91]
δ_c^1	.0665* [2.658]	-1.5058 [-.935]	.0560 [.360]	-.0695 [-1.051]	3.6550 [.994]	1.3459 [.627]	-.0254 [-.258]	.240 [1.30]
Lik.	70.49	70.21	67.53	70.06	68.26	69.17	68.48	68.20
MSE	.4818	.4590	.4619	.4719	.4549	.4551	.4613	.4564
TP	.1516	.1065	.1022	.1661	.1039	.0972	.1059	.0994

Table 14: Z_t=Lagged Differences Between the Italian and German Variables (1 lag)

	DEBTD	ΔINFD	IPD	ΔRERD	TBD	M2/RD	ΔGDPD
μ_n	.0893* [2.307]	.0860** [1.875]	.0746** [1.771]	.0699** [1.747]	.0633 [1.373]	.0787* [2.237]	.0741** [1.753]
μ_c	.3459* [2.094]	.5247* [2.313]	.5707* [2.455]	.5761* [2.601]	.5165* [2.227]	.3471* [2.280]	.5630* [2.394]
ρ_n	.4187* [4.782]	.5543* [7.618]	.5284* [7.219]	.5352* [7.432]	.5448* [6.412]	.4136* [4.992]	.5322* [6.864]
σ_n^2	.0619* [14.20]	.0803* [14.40]	.0775* [15.90]	.0743* [13.40]	.0719* [12.49]	.0578* [14.91]	.0764* [14.93]
σ_c^2	1.5349* [8.557]	1.9168* [8.023]	1.8449* [6.242]	1.8059* [7.912]	1.7035* [7.996]	1.4026* [9.712]	1.8236* [7.742]
δ_n^0	2.652** [1.767]	2.5876* [6.866]	2.7815* [6.2415]	2.6319* [6.529]	1.6279* [2.362]	.1698 [.100]	2.6722* [6.624]
δ_n^1	-.0010 [-.039]	.1755 [.205]	.0866 [.7089]	-.3306 [-.989]	-4.633 [-1.518]	-1.8682 [-1.379]	-.0432 [-1.55]
δ_c^0	-4.146* [-2.007]	.9386 [1.284]	.8958** [1.908]	.5951 [.997]	1.382** [1.904]	-7.951* [-2.439]	.8465 [1.578]
δ_c^1	.0792* [2.452]	5.898** [1.688]	.0426 [.319]	-.0640 [-.469]	5.529** [1.639]	-7.089* [-2.554]	-.0017 [-.067]
Lik.	68.86	66.73	67.26	67.37	68.76	70.26	68.37
MSE	.4845	.4669	.4564	.4562	.4557	.4805	.4539
TP	.2229	.1545	.1039	.1107	.1705	.2426	.1087

Table 15: Z_t = Lagged Italian Variables and External Variable (2 lags)

	DEBT	ΔINF	ΔIP	ΔRER	TB	M2/R	ΔGDP	ΔDM$
μ_n	.0737** [1.634]	.0736** [1.753]	.0589 [1.386]	.0839* [2.299]	.0641 [1.511]	.0665 [1.599]	.0549 [1.238]	.0718 [1.54]
μ_c	.5393* [2.488]	.5787* [2.500]	.5902* [2.780]	.4014* [2.114]	.5705* [2.650]	.5961* [2.671]	.5602* [2.763]	.5778* [2.60]
ρ_n	.5421* [6.757]	.5477* [7.103]	.5583* [7.563]	.4227* [5.092]	.5597* [7.366]	.5590* [7.549]	.5629* [7.461]	.5466* [7.72]
σ_n^2	.0737* [14.70]	.0776* [14.72]	.0729* [15.59]	.0627* [13.79]	.0722* [13.78]	.0746* [14.49]	.0706* [14.79]	.0763* [14.5]
σ_c^2	1.7622* [7.99]	1.8836* [8.043]	1.7666* [10.30]	1.6284* [9.079]	1.7557* [7.915]	1.8445* [8.518]	1.6489* [9.102]	1.848* [7.89]
δ_n^0	2.919** [1.940]	3.0129* [6.123]	2.6598* [6.919]	2.4998* [5.891]	2.2866* [5.272]	4.5053* [4.165]	2.3189* [5.488]	2.757* [6.86]
δ_n^1	-.0031 [-.169]	1.766** [1.819]	.1573 [.976]	.1341* [2.370]	-4.7124 [-1.531]	-3.876* [-2.141]	.3495 [.907]	.0612 [.391]
δ_c^0	-3.6015 [-1.627]	.8046 [1.477]	1.0540* [1.997]	.7652 [1.576]	.6689 [1.273]	-.5938 [-.462]	3.378** [1.958]	.918* [1.97]
δ_c^1	.0488* [2.073]	-.3388 [-.209]	-.2558 [-1.620]	-.0449 [-.747]	2.6577 [.776]	2.3736 [1.096]	-2.36** [-1.866]	-.085 [-.369]
Lik.	69.76	68.48	68.93	69.53	68.80	70.58	71.71	67.05
MSE	.4658	.4608	.4483	.4714	.4584	.4549	.4485	.4572
TP	.1091	.0940	.1055	.1430	.1037	.1168	.1164	.0956

Table 16: Z_t=Lagged Differences Between the Italian and German Variables (2 lags)

	DEBTD	ΔINFD	IPD	ΔRERD	TBD	M2/RD	ΔGDPD
μ_n	.0736** [1.640]	.0735** [1.741]	.0597 [1.351]	.0770* [2.400]	.0615 [1.468]	.0693 [1.584]	.0592 [1.368]
μ_c	.5378* [2.506]	.5696* [2.583]	.5909* [2.703]	.3594* [2.545]	.5293* [2.386]	.5273* [2.194]	.5732* [2.821]
ρ_n	.5418* [6.837]	.5504* [7.200]	.5643* [7.828]	.3866* [5.049]	.5481* [6.479]	.5419* [6.246]	.5667* [8.118]
σ_n^2	.0735* [14.57]	.0771* [14.67]	.0736* [14.43]	.0601* [14.48]	.0694* [12.28]	.0716* [12.44]	.0729* [14.53]
σ_c^2	1.759* [8.012]	1.8547* [7.916]	1.7587* [8.516]	1.3532* [9.514]	1.6498* [7.808]	1.6959* [7.858]	1.7121* [8.677]
δ_n^0	2.9534* [2.445]	2.9031* [6.731]	2.6266* [6.997]	4.3817* [3.658]	1.9082* [3.041]	1.2560 [.981]	2.5524* [6.751]
δ_n^1	-.0049 [-.252]	1.0895 [1.433]	.0665 [.582]	-.1490 [-1.475]	-3.4359 [-1.359]	-1.0274 [-1.132]	.0440 [.242]
δ_c^0	-2.929 [-1.588]	.8512** [1.741]	.9505** [1.832]	2.210** [1.819]	1.748** [1.747]	-2.9228 [-1.295]	1.2964* [2.099]
δ_c^1	.0528* [2.148]	.0592 [.087]	-.1704 [-1.367]	-.177** [-1.905]	7.1392 [1.563]	-2.66** [-1.641]	-.8226 [-1.389]
Lik.	69.99	67.62	67.79	70.25	70.23	68.66	68.57
MSE	.4661	.4613	.4492	.4812	.4633	.4642	.4497
TP	.1098	.0967	.1022	.2052	.1209	.0960	.1051

Figure 8a: p_{cc} $DEBT_t$

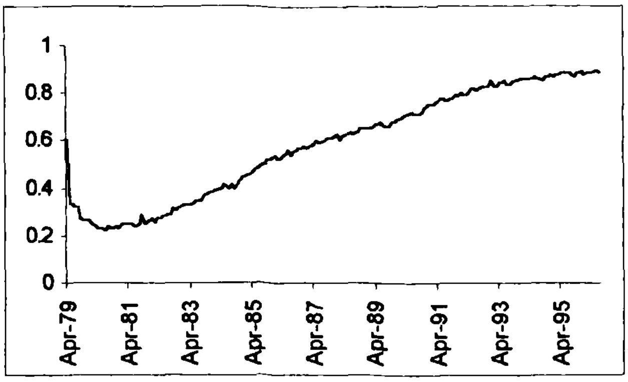


Figure 8b: p_{nn} $M2/R_t$

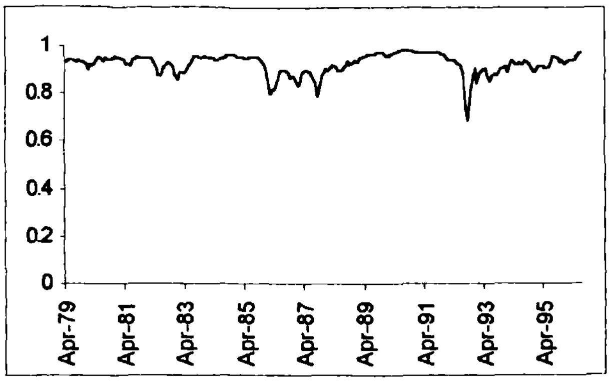


Figure 8c: p_{cc} $DEBTD_t$

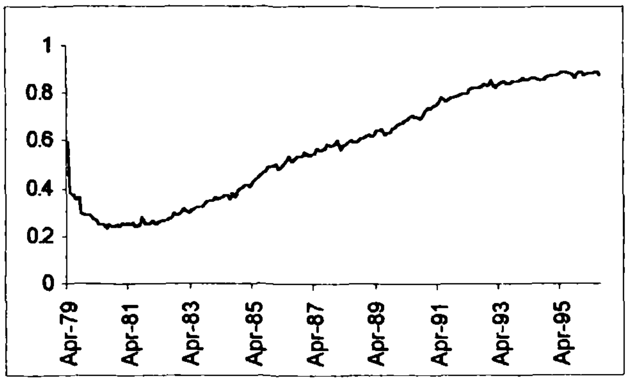


Figure 8d: p_{nn} IPD_t

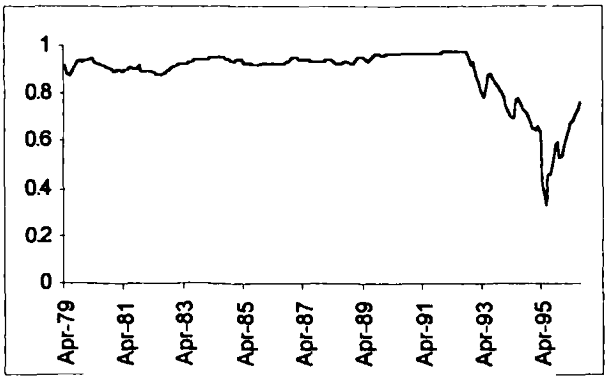


Figure 8e: p_{cc} $DEBT_{t-1}$

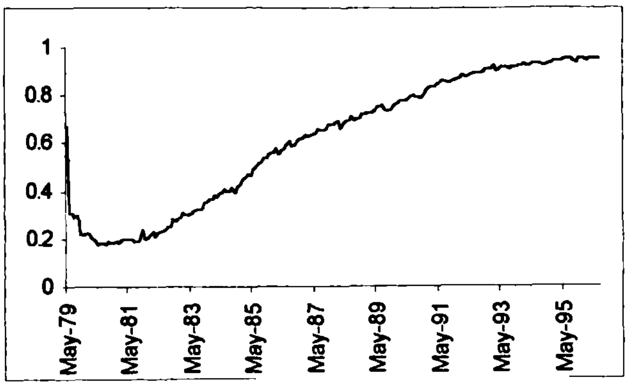


Figure 8f: p_{nn} $M2/R_{t-1}$

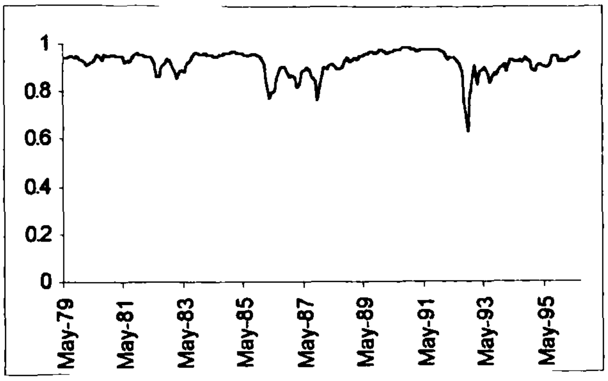


Figure 8g: p_{cc} $DEBTD_{t-1}$

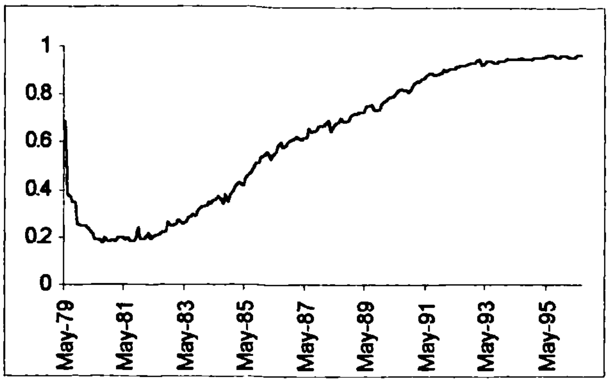


Figure 8h: p_{cc} $INFD_{t-1}$

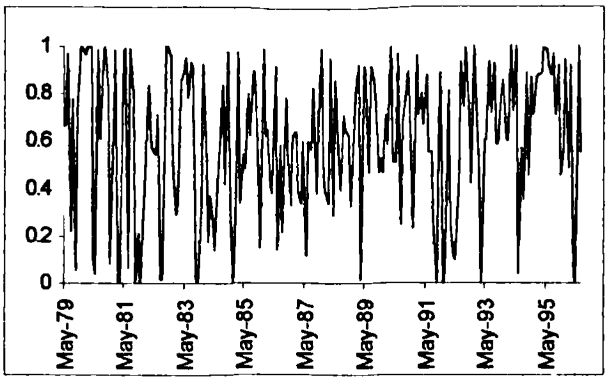


Figure 8i: p_{cc} $DEBT_{t-2}$

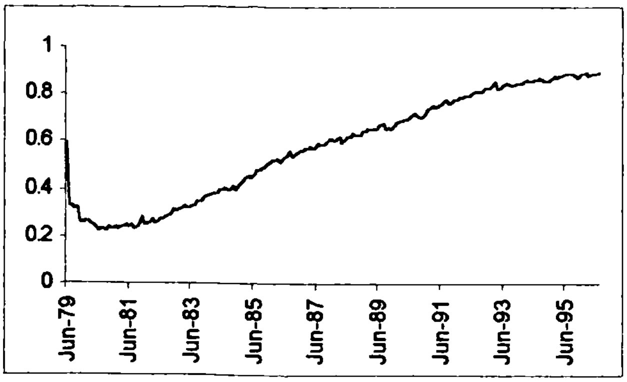


Figure 8j: p_{nn} $M2/R_{t-2}$

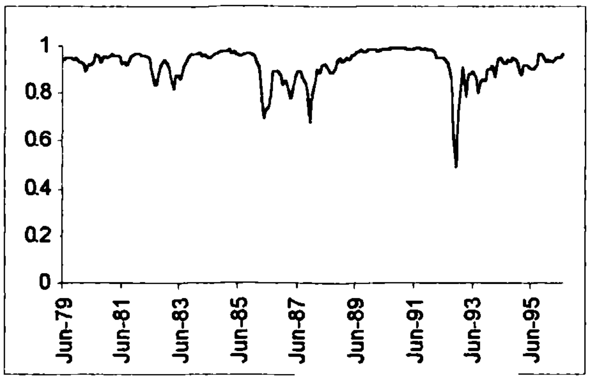


Figure 8k: p_{cc} GDP_{t-2}

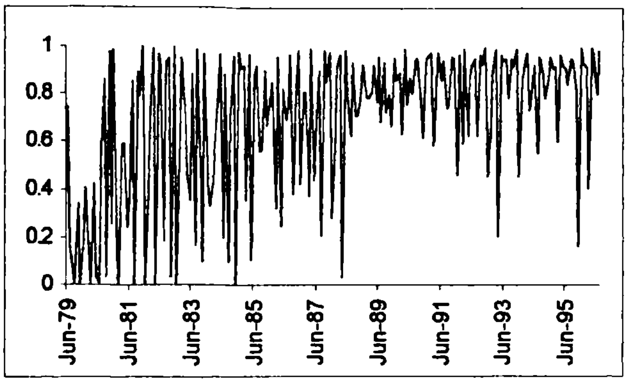
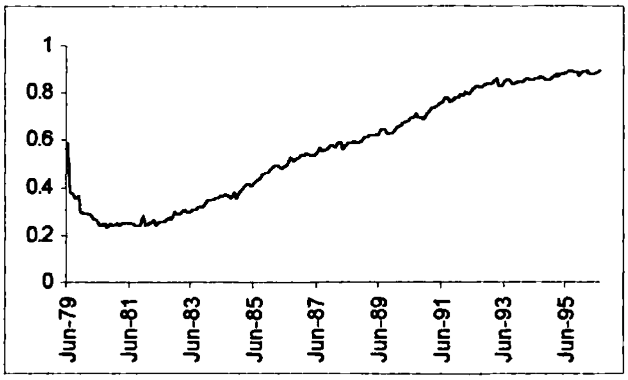


Figure 8*l*: p_{cc} $DEBTD_{t-2}$



5. 5. 3. Conclusions on the Lira

Clearly the ratio of debt to GDP does have a strong influence on transitions from the crisis state. Current, one-month- and two-month-lagged ratio of debt to GDP, whether taken on their own or relative to the German debt/GDP ratio, are all statistically significant and display the expected sign in the crisis state. Such evidence probably does not come as a surprise given Italy's well known record of high debt levels. By 1992, particular and growing importance was given to the problem of public finances in Italy and, more precisely, to the weakness of the government's resolve to halt the rise of public debt in proportion to GDP. The government's failure, year after year, to achieve its own budgetary targets intensified doubts about the sustainability of the Italian fiscal position so that the state of the Italian public finances was widely viewed by economic agents as a broad problem affecting the economic and political system[32].

Most studies investigate the composition -short-term vs. long-term; floating-rate vs. fixed-rate; and domestic currency vs. foreign currency denomination- and maturity of debt[33], whilst the central focus of this study is on the stock of debt. In this context, our results can be compared to Thomas (1994) who finds a positive significant relationship between the Italian relative debt to GDP ratio and the risk of a lira devaluation. It is also interesting to note that our results confirm the inference drawn by Eichengreen & Wyploz (1993) who find that the imbalance in Italian public finances -the budget deficit and the level of public debt- were a potential source of speculative pressure against the lira.

Apart from debt, other variables also play some role in explaining pressure on the lira. Transitions from the crisis state are influenced by the one-month-lagged inflation differential between Italy and Germany, as well as by the two-month-lagged growth rate of GDP. That is, the index of EMP is more likely to remain in the crisis state whenever the inflation differential worsens in the previous month, or Italian GDP growth deteriorates two months ago.

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[32] See Chapter 3 for details of the macroeconomic environment prior and during the Italian crisis.

Transitions from the normal state are also determined by two variables in particular. The lower the ratio of monetary aggregate M2 to reserves, the higher the probability that the index of EMP will stay in the stable state. Indeed, the current, one-month-lagged and two-month-lagged ratios of M2 to Reserves are all statistically significant in the normal state. The value of M2/R that triggers a switch from the normal to the crisis regime is only reached in September 1992. This confirms the evidence in Goldstein et al. (1993) that the amount of international reserves held by the Bank of Italy showed that speculative pressure on the lira was extremely high. Likewise, the higher the current industrial production differential between Italy and Germany, the more likely is the index of EMP to remain in the stable state.

As in the case of the French franc, the relevant exogenous variables have an asymmetric effect on the two states (i.e. most of them affect one state but not the other). Variables that do not play any role in explaining switches from either state include the real exchange rate (or competitiveness) and the change in the trade balance. The fact that competitiveness is not important in our study is however striking in the sense that Italy certainly showed evidence of deteriorating international competitiveness by the time of the 1992 crisis[34]. It also strikes us that the Italian lira was not found to be subject to any pressure from movements in the German mark/dollar exchange rate in the period under study.

5. 6. Conclusions

This chapter has attempted to measure speculative pressure on the French franc and Italian lira and to evaluate whether, and how, switches in the level of pressure may be influenced by a specific set of exogenous variables.

The well-established speculative attack episodes were satisfactorily identified by the regime switching methodology. Moreover, the rapid move of the probability of crisis from one extreme to the other showed that episodes of high speculative pressure are

[33] See, for example, Frankel & Rose (1996) and Sachs et al. (1996).

very volatile and short-lived for both currencies. The evidence presented in this chapter therefore confirms the conclusions of Hiesh (1994), Gomez-Puig & Montalvo (1997), Martinez (1998) and Tronzano (1999) that the regime switching technique provides a useful statistical tool to identify currency crises in the EMS. It also corroborates the good performance of previous studies that use the index of exchange market pressure to examine currency crises[35].

More importantly, crises seem to be determined by some economic variables (in particular, unemployment and trade balance in France, and debt in Italy). Other variables appear to prolong tranquil periods (mainly, output growth and the inflation differential in France, and the ratio of M2 to reserves in Italy). Again our results are consistent with other related studies. As discussed above, Jeanne (1997); Okter & Pazarbasioglu (1997); and Jeanne & Masson (1998) come to similar conclusions regarding the franc. There are unfortunately few related papers on the Italian lira to compare our results with. The most relevant, Martinez (1999), does not reach any specific conclusion on the determinants of Italian speculative attacks. Some variables which, in theory, should precipitate or characterise currency crises were not significant in triggering switches between regimes. Notably, shifts in the level of speculative pressure were not sensitive to the German mark depreciation rate against the dollar, which is in sharp contrast with the widely spread argument that a dollar appreciation typically leads to pressure in the ERM[36].

In the sense that only a relatively small set of variables played a significant role in the empirical determination of the identified currency crises, it may be that crises occur too suddenly and unexpectedly to be adequately explained by economic factors. It may therefore be possible to improve the estimation results by extending the set of explanatory variables to the arrival of news and government preferences. It would also

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[34] See Eichengreen & Wyploz (1993) for inference.

[35] See Eichengreen et al. (1995, 1996), Sachs et al. (1996), Kaminsky et al. (1998) and Berg & Patillo (1998).

[36] Instead, it was found that German mark depreciation has a positive effect on the probability of remaining in the crisis regime. There may be two explanations for this counterintuitive observation. First, the mark/dollar exchange rate may influence transition probabilities in level rather than in changes. Secondly, a rise in the mark/dollar one or two months ago may cause Germany to tighten monetary policy to preclude any inflationary tendency, which may lead to pressure on the ERM parities.

be interesting to compare the results for other currencies such as the Mexican peso, the Russian rouble and East Asian currencies. Finally, a natural development would be to try other indicators of pressure on currencies. An obvious candidate is the drift-adjusted devaluation expectation for which evidence is offered in Chapter Six.

Chapter 6
Realignment Expectations

6. 1. Introduction

The aim of this chapter is to re-estimate the FTP and TVTP Markov regime switching models using an alternative measure of speculative pressure so as to compare the inference regarding the French and Italian currency crises. The crisis proxy now is the so-called drift-adjusted expected realignment rate; a variable that takes into account the fact that exchange rate fluctuations in the ERM are bounded within a specified band around a specified parity.

The literature on the effect of currency bands on exchange rates mushroomed in the early 1990s, following the seminal paper by Krugman (1991) on target zones and exchange rate dynamics[1]. Extensive research has since been devoted to the issue of managed exchange rate credibility. In the absence of any commonly accepted measure of currency credibility, many papers employ interest rate differentials to study the experience of managed exchange rate mechanisms. However, work by Rose & Svensson (1991), Lindberg & Söderlind (1991) and Svensson (1993) prove that the use of interest rate differentials as a measure of expected devaluation can be improved upon by taking into account the expected depreciation within the band. These studies indicate that estimates of expected rates of currency depreciation within the band for ERM exchange rates, for time horizons of up to one year, are often of the same order of magnitude as the interest rate differentials (up to 2-3% per year)[2]. Therefore, the use of interest rate differentials as indicators of target zone credibility, without adjusting for expected rates of depreciation within the band, is probably inappropriate for horizons up to one year.

The pioneering empirical research on realignment expectations was conducted by Svensson (1991, 1993). The empirical implementation of the method has since been extensive[3] and has generally demonstrated that the adjustment of interest rate differentials is essential to measure

[1] Earlier work on exchange rate target zones was done by Williamson (1985), and Williamson & Miller (1987).

[2] Svensson (1993) explains that this observation is the result of exchange rates in the ERM bands displaying mean reversion.

devaluation expectations precisely. The approach adopted in the present chapter however differs from previous studies in two meaningful aspects. It is the first study that applies the regime-switching model with time varying transition probabilities to drift-adjusted devaluation expectations. It is also one of the few studies to investigate the relationship between realignment expectations and macroeconomic variables in a non-linear way[4].

The remainder parts of the chapter are organised as follows. Section Two provides an overview of the target-zone model to provide the theoretical foundation for the drift-adjustment. The following section gives the details of the drift-adjustment technique and discusses methodological issues regarding the estimation of expected devaluation within the band. Sections Four and Five present the estimation results of the drift-adjustment and the regime-switching model with fixed and time varying transition probabilities for France and Italy, respectively. Finally, the conclusions are drawn in Section Six

6. 2. The Target Zone Model

Target-Zone (henceforth TZ) models have been developed to describe the functioning of the ERM, as pioneered by Krugman (1991) and further extended by, among others, Flood & Garber (1991), Froot & Obstfeld (1991), Miller & Weller (1991) and Sutherland (1994)[5]. The structural form of the model is based on the flex-price monetary model of exchange rate determination that assumes equilibrium in the money market, Purchasing Power Parity and Uncovered Interest Parity. The basic (strong) assumptions of the standard target zone model are the following. Market operators are fully confident that the exchange rate will not go beyond the limits of the fluctuation bands (because the monetary authorities will defend these limits). Expectations are rational[6]; and intervention is exclusively 'marginal', i.e. intervention takes place only when the exchange rate reaches the edges of the fluctuation band.

[3] Chen & Giovannini (1993), Caramazza (1993), Thomas (1994), Rose & Svensson (1994, 1995), Jeanne (1997) and Jeanne & Masson (1998).
[4] To our knowledge, only Jeanne (1997) and Jeanne & Masson (1998) attempt to test for non-linear relationships between French realignment expectations and fundamentals.
[5] See Svensson (1992) and Krugman & Miller (1992) for survey of the target zone literature.
[6] In practice, there is a major tension in any analysis of exchange rates between the analytics of Efficient Market Theory and the growing evidence that the theory is an inadequate empirical description, leaving us with the question of how realignment expectations are formulated and evolve over time.

In short, the basic TZ model assumes that the exchange rate is a linear function of its expected change plus an aggregate "fundamental" that incorporate its different fundamental determinants (domestic money supply, output, the price level, foreign interest rates, etc.). The simple equation linking the log of the exchange rate, s, with the fundamental, k, and the expected change in the exchange rate $E_t(s_t)$ is: $s = k + \alpha E(ds)/dt$. The fundamental itself is a composite function of money supply, which is controlled by the central bank via intervention and "velocity", which is exogenous to the central bank and stochastic. Hence, $k \quad m + v$, where m is the natural logarithm of money supply, v is a stochastic disturbance assumed to follow a driftless Brownian motion process[7].

Figure 1: Exchange Rate Movement in a Basic Target Zone Model

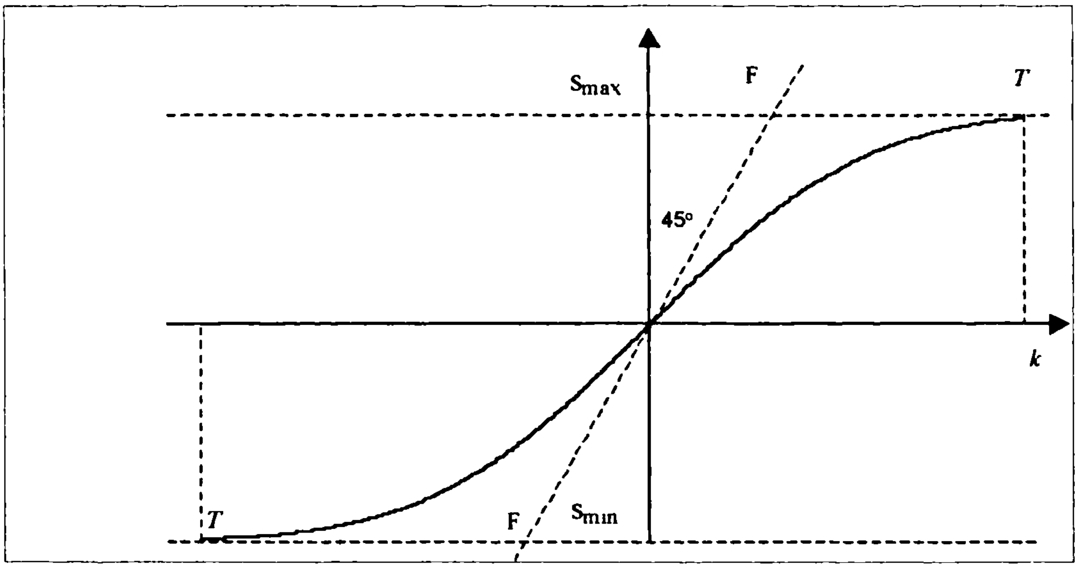


Figure 1 is the plot of the exchange rate on the vertical axis against the fundamentals on the horizontal axis. The horizontal dashed lines are the edges of the band. Under a free float, the central bank is assumed not to alter money supply. Since the exchange rate is a Brownian motion without drift, the expected exchange rate change is zero and, therefore, the exchange rate will depend linearly on the fundamental only. In fact, using normalisation, the exchange rate becomes equal to the fundamental. In Figure 1, the free-float line is therefore the 45° line (line *FF*). In the target zone, when the exchange is within the band, $s \in]s_{max}, s_{min}[$, money

[7] A Brownian motion without drift is the continuous-time equivalent of a random walk. Its realised sample paths do not include discrete jumps. Changes in the variable in any fixed time interval are normally distributed with zero mean and variance equal to the duration of the time interval.

supply also remains unchanged. However, the central bank alters m to offset changes in v only when the exchange rate hits the upper (s_{max}) or lower (s_{min}) edges of the band. The technical solution to the basic target zone model therefore implies that the relationship between the fundamental and the exchange rate is represented by a non-linear, S-shaped curve pasted smoothly onto the upper and lower band limits (line *TT*).

'Smooth-pasting' means that the S-curve flattens to a slope of zero at the edges of the band, i.e. the exchange rate is totally insensitive to the fundamental at the boundary of the exchange rate zone[8]. Furthermore, the exchange rate exhibits the 'honeymoon' characteristic, whereby the S-shaped curve lies below the 45° line in the upper half of the figure and above it in the lower half (its slope is less than one at all times). This is because the expected exchange rate change becomes negative (the currency is expected to appreciate) as the exchange rate moves closer to the upper (weak) limit and, therefore, the target zone exchange rate is less than the free float rate, for a given value of the fundamental. Conversely, the expected rate of depreciation is positive when the exchange rate is at the lower (strong) edge of the band implying that the exchange rate is higher than if there were no probability of intervention, for a given level of the fundamental. The implication of the honeymoon characteristic is that a perfectly credible target zone is inherently stabilising in the sense that exchange rate fluctuations are less for any given range of fundamental fluctuation with a band than without the band. Under a free float, the exchange rate moves up and down the 45° line whilst inside the band, given that the S-curve is flatter, shocks to velocity have smaller effects on the exchange rate, although the central bank does not intervene to stabilise it.

An important empirical inference of TZ exchange rates is the negative relationship between the expected rate of devaluation and the spot exchange rate; or "mean reversion"[9]. This tells us that the expected future exchange rate within the band is closer to its long-run mean, the further away it is in time. Under the two assumptions of uncovered interest rate parity and perfect credibility, the interest rate differential is equal to the expected rate of currency depreciation within the band. That is, a plot of the interest rate differentials against the exchange rates

[8] The intuition for the smooth pasting property of the exchange rate is far from easy and has received considerable theoretical interest but falls outside the purpose of this chapter. For more details, see Krugman & Miller (1992) and Svensson (1992a).
[9] Svensson (1992a) recalls that the mean-reversion property is independent of the validity of the specific Krugman model.

relative to the centre of the band should depict a strongly negative deterministic relationship. However, empirical work by Svensson (1991), among others, dismisses this deterministic relationship and often reveal that the correlation between the interest rate differential and the exchange rate is positive or zero[10]. So, although the ERM rules appeared to resemble the main features of the TZ model, exchange rate behaviour in the ERM failed to conform to the principal predictions of the model. Both structural estimation of the parameters of the model, and simple plots of the exchange rate against the estimated fundamental, explicitly reject the model.

In view of the practical functioning of the ERM, models have subsequently allowed for intramarginal intervention. Lindberg & Soderlind (1992) model intramarginal intervention as a mean-reverting process for fundamentals, which results in the exchange rate distribution becoming U-shaped with a hump in the centre (as the exchange rate spends more time near the centre of the band when intramarginal intervention is exercised). Dominguez & Kenen (1992) also offer evidence that intra-marginal intervention by European central banks may explain the perpetuation of differences between the actual behaviour of exchange rates and the presumptions of the model. Another extension -by Sutherland (1994)- investigates the implications of a sticky-price TZ model and finds that, empirically, the latter performs better than the flex-price model. Further work in this area has extended the basic model by incorporating realignment risk in the analysis, i.e. imperfect credibility.

Investigating this assumption, Svensson (1991) examines whether forward exchange rates for different maturity fall outside the exchange rate band in a so-called "simple test". Svensson rejects the assumption of perfect credibility given that for most currencies and maturities, the forward exchange rate falls outside the fluctuation band. Most importantly, the results lead Rose & Svensson (1991) to develop a new empirical methodology for estimating of realignment expectations: “the drift-adjustment technique” which consists in splitting the total expected depreciation rate into two components; i.e. the expected rate of currency depreciation within the band and the expected rate of realignment.

[10] Svensson (1991) conducts tests on data from the Gold Standard era, the Bretton Woods system, the Nordic

6. 3. The Drift-Adjustment Methodology

6. 3. 1. Methodological Procedure

The methodological procedure adopted by, *inter alia*, Svensson (1993), Rose & Svensson (1994)[11] to measure realignment expectations -the drift-adjustment- is as follows: first decompose the interest rate differential into the expected change in the exchange rate within the band and the expected realignment itself. Next, estimate an equation for the expected movements within the band, so as to subtract it from the interest rate differentials and finally obtain estimates of the expected realignment.

Let $e, e^L, and\ e^U$ denote the natural logarithms of the spot exchange rate and its lower and upper intervention rates, respectively. By definition, the exchange rate can be decomposed as $e_t \equiv c_t + x_t$, where $c_t \equiv (e_t^L + e_t^U)/2$ is the log of the central parity of the concerned exchange rate and x is the deviation of the currency from the central parity. Note therefore that the rate of change of the deviation of the currency from the central parity within the band between period t and $t+m$, Δx_{t+m}, is bounded by $(e^L - e)/m \le \Delta x_{t+m}/m \le (e^U - e)/m$.

Taking first differences of the exchange rate, the total expected change in the exchange rate from time t to $t+m$ -conditional on information at time t- is equal to the expected rate of realignment (i.e. the change in the central parity) plus the expected rate of change of the currency within the band:

$$E_t \Delta e_{t+m}/m \equiv E_t \Delta c_{t+m}/m + E_t \Delta x_{t+m}/m \qquad (1)$$

Assuming Uncovered Interest Parity (UIP):

$$i_t^m - i_t^{*m} = E_t \Delta e_{t+m}/m \qquad (2a)$$

$$\text{so } E_t \Delta c_{t+m}/m = (i_t^m - i_t^{*m}) - E_t \Delta x_{t+m}/m \qquad (2b)$$

countries and the EMS

[11] The theoretical aspect of the drift-adjustment method was suggested by Bertola & Svensson (1993) in a target zone model with stochastic time varying devaluation risk It was empirically implemented first in Rose & Svensson (1991) and Lindberg & Söderlind (1991) and used later in many papers.

where i is the domestic interest rate and i^* is the foreign interest rate.

Even though UIP is frequently rejected empirically[12] it has been extensively used in the context of the ERM. The use of the parity condition implicitly implies that the foreign exchange premium -deriving from uncertainty both in exchange rate movements within the band and in the realignment of the parity- is insignificant. Svensson (1992b) argues that the first component is trivial given that empirical estimates of foreign exchange premia within a narrow band, and even in a free float, are small. Svensson further shows that, although the second component is presumably much larger than the first, its size still remains moderate so that the greater portion of the interest rate differential is to be explained by factors other than the foreign exchange rate premium. Svensson (1992b) finds that the risk of a large devaluation with risk-averse agents would only results in a foreign exchange risk premium of no more than a fifth of the size of the interest rate differential. Moreover, Rose & Svensson (1991) point out that the UIP works well for France because it suffered relatively few realignments and Drudi & Majnoni (1993) hold that the risk premium for the lira was only small when the lira moved to the narrow band.

ERM exchange rates within the band usually take a jump at a realignment. Commonly, for a currency that is devalued, the exchange rate jumps from the 'weak' (upper) edge of the old band to the 'strong' (lower) edge of the new one; and *vice versa* for a currency that is revalued. Therefore, even though jumps in the exchange rate inside the band -if any- are generally less than the jump in the central parity, estimates of the expected rate of realignment within the band should account for their possible occurrence.

A Peso problem is also likely to emerge in the estimation, thus making the econometric estimation of the expected rate of depreciation within the band more complicated[13]. The Peso Problem is a situation in which a small probability is attached to a large change in the central

[12] In particular for floating exchange rates. See Froot & Thaler (1990) and Taylor (1995a&b) for review.

[13] The Peso Problem was originally attributed to the behaviour of the Mexican peso during the early 1970s. The peso had been pegged against the dollar since 1954, however the market started to expect that it would be devalued in the early 1970s. The devaluation occurred in 1976. This produced a skew in the distribution of forecast errors since market expectations of future rates systematically underestimated the actual future rate (i.e. forecast errors were systematically positive). It contradicted the rational expectations hypothesis that forecast errors should be zero on average.

parity that does not occur in the sample[14]. In the present case, it would derive from the fact that there have only been 'few' realignment in the ERM and the sample distribution of realignments may not be representative.

In this respect, the practice is to estimate the expected rate of depreciation within the band *conditional upon no realignment*. The expected change of the exchange rate within the band is split into two components:

$$\begin{aligned} E_t[\Delta x_{t+m}] &\equiv (1-p_t^m)E_t[\Delta x_{t+m} / \textit{no realignment}] + p_t^m E_t[\Delta x_{t+m} / \textit{realignment}] \\ &\equiv E_t[\Delta x_{t+m} / \textit{no realignment}] - p_t^m \{E_t[x_{t+m} / \textit{no realignment}] - E_t[x_{t+m} / \textit{realignment}]\} \end{aligned} \tag{3}$$

where p_t^m is the probability of a realignment from date t up to and including date $t+m$. Note that the possibility of more than one realignment between t and $t+m$ is disregarded given that in this thesis the maturity used is one month and there never was more than one realignment in one month during the ERM period.

From (3), it follows that (2b) can be rewritten as:

$$y_t^m = \delta_t^m - E_t[\Delta x_{t+m} / \textit{no realignment}]/m \tag{4}$$

where: $\delta_t^m \equiv i_t^m - i_t^{*m}$ denotes the domestic currency's interest rate differential at time t and y_t^m is the expected rate of devaluation for period $t+m$.

The expected rate of devaluation equals the difference between the interest rate differential and the expected rate of depreciation within the band (conditional upon no realignment). Hence the operational definition of the expected rate of devaluation is:

$$y_t^m \equiv E_t[\Delta c_{t+m}]/m + p_t^m \{E_t[x_{t+m} / \textit{realignment}] - E_t[x_{t+m} / \textit{no realignment}]\}/m \tag{5}$$

which can be rewritten as:

$$y_t^m \equiv v_t^m \left\{ \begin{aligned} &E_t[\Delta c_{t+m} / \textit{realignment}] \\ &+ E_t[x_{t+m} / \textit{realignment}] - E_t[x_{t+m} / \textit{no realignment}] \end{aligned} \right\} \tag{6}$$

[14] The use of daily data does not exclude this "small sample" problem since the data does not vary much.

where $v_t^m \equiv p_t^m / m$ is the frequency of realignment.

Hence, the expected rate of devaluation is the product of the frequency of realignment and the expected conditional devaluation size (conditional upon a realignment). The expected conditional devaluation size is the sum of the expected conditional realignment size and the difference between the expected exchange rate at maturity and the expected rate at maturity conditional upon no realignment.

This latter difference, when the maturity *m* goes toward zero, thus denotes the jump in the exchange rate within the band at a realignment. In other words, the expected conditional devaluation size -or expected actual jump in the (total) exchange rate- equals the difference between the jump in central parity and the jump in the exchange rate within the band.

6. 3. 2. Estimation of Expected Movements Within the Band

Most papers using the drift-adjustment methodology estimate the expected rate of depreciation within the band $E_t[\Delta x_{t+m} / no\ realignment]/m$. However, for convenience we follow Rose & Svensson (1995) and estimate the expected future exchange rate within the band $E_t[x_{t+m} / no\ realignment]$ (the relationship between the two variables is given by the following: $E_t[\Delta x_{t+m} / norealignment]/m \equiv \{E_t[x_{t+m} / norealignment] - x_t\}/m$). Note that in the following exchange rates are measured as a deviation from the central parity.

An estimate of the expected future exchange rate can be obtained by regressing the exchange rate one month ahead on the current exchange rate, the interest rate differential and regime shift dummies (a regime is the period between two realignments). In addition, non-linear terms can be included to be consistent with the standard target zone theory according to which the relationship between the expected rate of currency depreciation within the band and the actual exchange rate should be non-linear. Although some papers restrict the estimation to a linear equation[15], it seems more prudent to allow for non-linearity as Rose & Svensson (1995) and test for their statistical significance. Likewise not all empirical studies of expected realignment rate include the interest rate differential as an explanatory variable[16] but, given that Svensson (1993) and Rose & Svensson (1994) find it statistically significant, it is considered important to incorporate it in our estimation and test for its significance.

The technique used to measure expected movement within the band relies on the Ordinary Least Squares (OLS) estimation of:

$$x_{t+m} = \sum_{i} \alpha_i + \beta_1 x_t + \beta_2 x_t^2 + \beta_3 x_t^3 + \rho\delta_t + u_{t+m} \tag{7}$$

where E_t denotes the expectation operator; x_t denotes the deviation of the log of the spot rate from c, the log of the central parity; δ is the interest rate differential; u_{t+m} is a forecast error realised at time $t+m$, assumed to be orthogonal to information available at time t, and the different intercepts correspond to the periods between realignments vis-à-vis the DEM[17]. For example, for the franc α_1 is equal to one between the inception of the ERM and the first franc realignment and zero afterwards, α_2 is equal to one between the first and second franc realignment and zero otherwise, et cetera. Note that if a dummy variable is positive, it reflects a tendency for the exchange rate to be located at the lower (strong) edge of the band after a realignment, so that the currency depreciates over time to achieve mean reversion. Conversely, if the dummy variable is negative, the currency appreciates to attain mean reversion.

Following Rose & Svensson (1995) x_{t+m} is in fact $[x_{t+m} / \textit{no realignment}]$ which is obtained by eliminating the 22 observations prior to each realignment date (m=22 days corresponds to 1 month). Again, whether the expected future exchange rate is estimated "conditional upon no realignment" is not a fundamental methodological issue. It is a practical measure because the jump component that is expected at a realignment may not be estimated accurately in a given sample due to the standard peso problem.

[15] Rose & Svensson (1994) employ a linear regression for all the currencies under investigation although they reject the null hypothesis that the non-linear terms are not significantly different from zero. Svensson (1993), Thomas (1994) and Caramazza (1993) also opt for a linear relationship.

[16] Rose & Svensson (1995) do not find that the interest rate differential is a significant determinant of the future French franc exchange rate.

[17] For France, the six realignments define seven regimes (i=7) and for Italy the nine realignment correspond to ten regimes (i=10).

A possible drawback of the procedure are that movements within the band may reflect the change in market sentiment regarding the parity and that floating within the band is often managed in the form of sterilised intervention. It would however be difficult to ameliorate the methodology.

Equation (7) is estimated using OLS but given the "overlapping observations"[18] problem, the standard errors are computed using the Newey-West (1987) variance-covariance estimator to account for possible serial dependence and heteroskedasticity in u_{t+m}.

The least square regression coefficients, b, are computed by the standard OLS formula $b=(X'X)^{-1}X'y$, where y is the matrix associated with the left-hand-side variables and X is the usual matrix associated with the right hand side variables. The Newey-West estimator is given by $\hat{\Sigma}_{NW}(X'X)^{-1}\tilde{\Omega}(X'X)^{-1}$, where T is the number of observations, $\tilde{\Omega}=\frac{T}{T-k}\left\{\sum_{t=1}^{T}u_t^2 x_t x_t' + \sum_{v=1}^{q}\left((1-v/(q+1))\sum_{t=v+1}^{T}(x_t u_t u_{t-v} x_{t-v}' + x_{t-v} u_{t-v} u_t x_t')\right)\right\}$, k is the number of regressors, q, the truncation lag, is a parameter representing the number of autocorrelations used in evaluating the dynamics of the OLS residuals, u_t. Following the suggestion of Newey-West (1987), the econometric package used (Eviews) sets $q=(4(T/100)^{2/9})$. Note moreover that using the Newey-West Heteroskedasticity and Autocorrelation Consistent (HAC) covariance estimates does not change the point estimates of the parameters, only the estimated standard errors.

The data set consists of daily observations on interest and exchange rates for France, Italy and Germany collected in August 1996. The data sample begins with the onset of the ERM on March 13, 1979 and ends on July 30, 1993 for France and August 12, 1992 for Italy. Figures 2 and 4 show time series plots of the natural logarithm of the FRF/DEM and ITL/DEM exchange rates and their fluctuation bands. The realignment dates and sizes are given in Appendix A6 (Table A6.1). The franc band is ± 2.25 percent around the central parity and that of the lira is ± 6 percent until January 8,1990 and ± 2.25 percent thereafter. Figures 3 and 5 plot the one-

[18] See Hansen & Hodrick (1980).

month interest rate differentials between France and Germany, and Italy and Germany, respectively.

Figure 2: Natural Logarithm of the FRF/DEM Exchange Rate

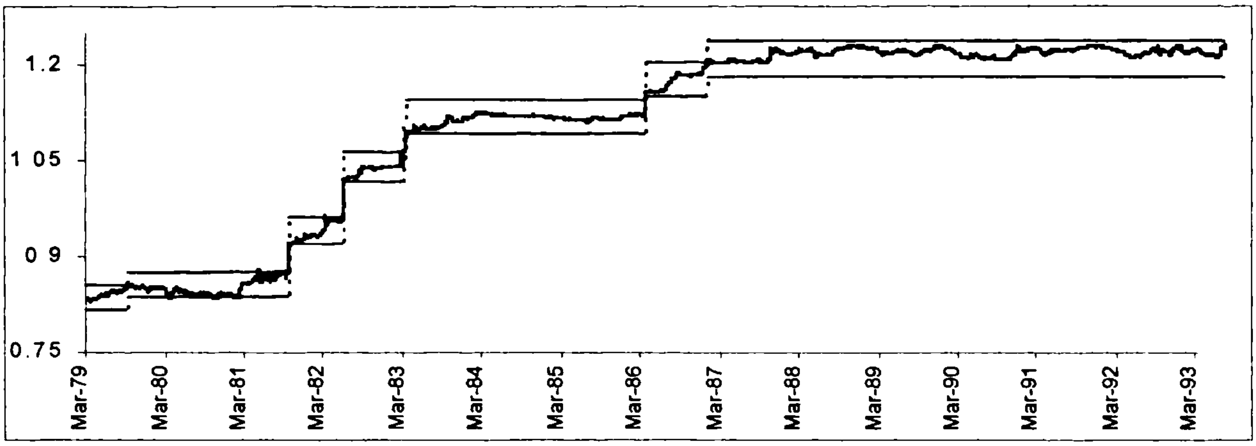


Figure 3: French-German One-Month Interest Rate Differential

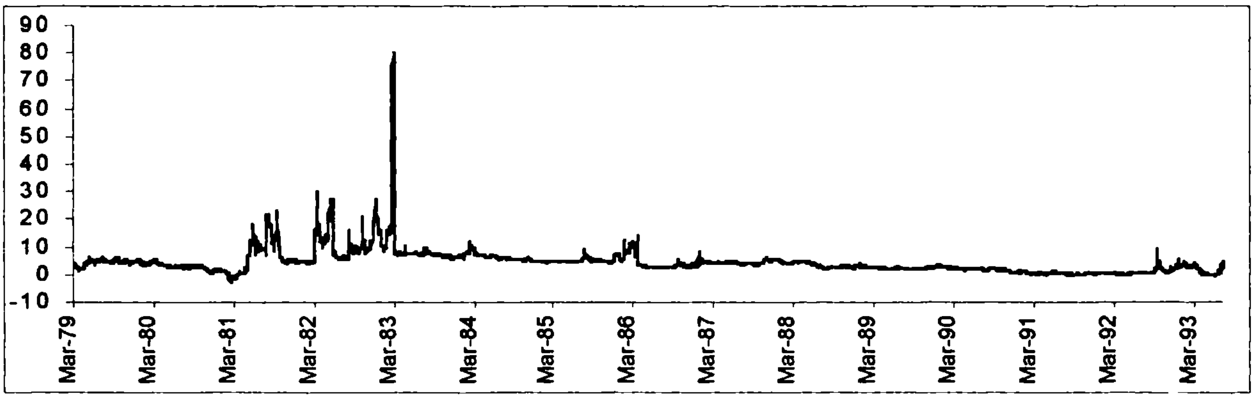


Figure 4: Natural Logarithm of the ITL/DEM Exchange Rate

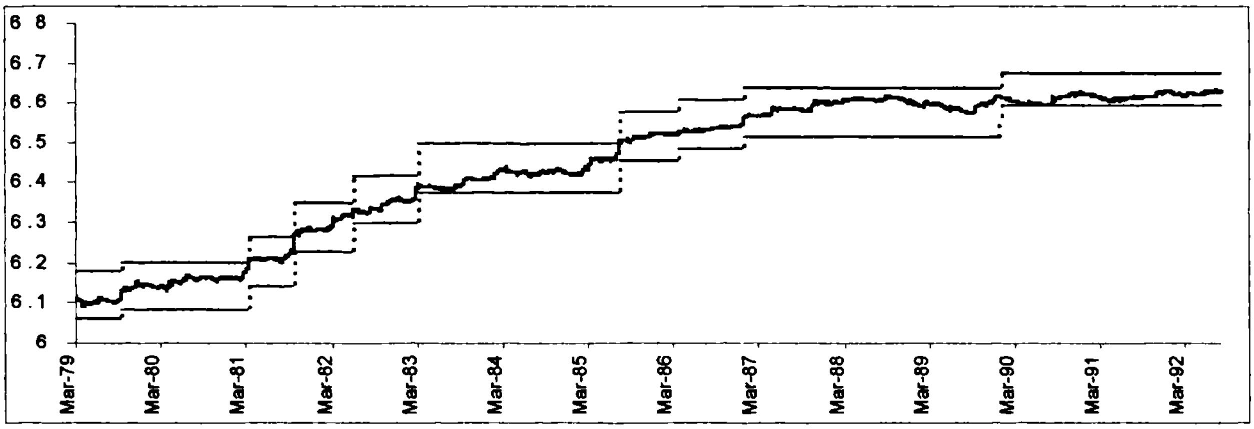
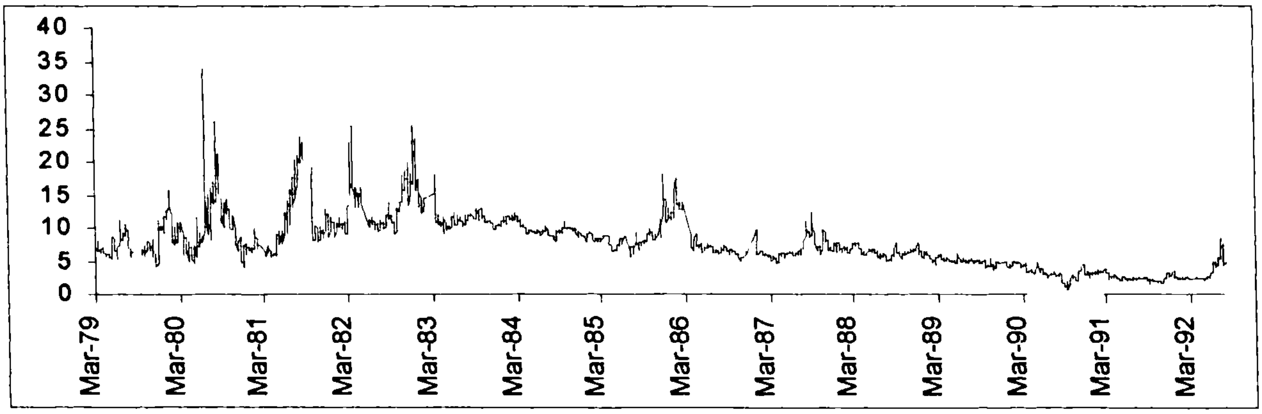


Figure 5: Italian-German Interest Rate Differential



6. 4. Results for the French Franc

6. 4. 1. Estimation of Realignment Expectations

Table 1 shows the results of the OLS estimation based on equation (7) for the French franc between March 13, 1979 and July 30, 1993. As explained above, because the data is overlapping and possibly heteroskedastic, Newey-West standard errors are computed to allow for both serial correlation and heteroskedasticity.

The French franc has seven regimes corresponding to the six realignments over the period. Regimes 1, 3, 4, 5, 6 and 7 have positive and statistically significant coefficients[1], reflecting a tendency for the exchange rate to be located at the lower (strong) edge of the band after realignment. The intercept for regime 2 is not statistically different from zero (note that in Table 1 of Rose and Svensson (1995), intercepts for regimes 2, 5 and 6 are statistically insignificant)[2]. The coefficient for the current exchange rate, x_t (measured in percent deviation from central parity), is positive and highly significant, which is in accordance with the theory of mean reversion[3]. The parameter for the interest rate differential is negative and statistically significant; a high domestic interest rate relative to Germany is therefore associated with

[1] Intercepts for regimes 3 and 6 are however only significant at the 10 percent level.

[2] In Rose & Svensson (1995) column 2 of Table 1 (pp. 188-189) is the closest to our estimation equation although it does not include the interest rate differential on the right hand side of the equation

appreciation. On the other hand, the quadratic and cubic terms are not significantly different from zero suggesting that there is no non-linear dependency. A likelihood ratio test was computed as LR $-2(l^R\text{-}l^U)$ where l^R and l^U are the maximised values of the log likelihood function of the unrestricted (non-linear) and restricted (linear) regressions, respectively. The null hypothesis, H_0, is that the additional set of regressors, x_t^2 and x_t^3, are not jointly significant. Under H_0, the LR statistic has an asymptotic χ^2 distribution with degrees of freedom equal to the number of restrictions, i.e. two, the number of added variables. The computed LR statistic for the sample is equal to 14.15 (with p-value=0.000) which means that the null hypothesis can be rejected. The quadratic and cubic terms were therefore included in the estimation[1]. Finally, the chosen specification appears to provide a relatively good fit of the expected future exchange rate with an adjusted R^2 equal to 76.78 percent, which is similar to the findings of Rose & Svensson (1995).

The fitted values, x_{t+m}, obtained with the above specifications are plotted in Figure 6. Although the estimation procedure does not explicitly take into account the fact that the expected future exchange rate cannot fall outside the fluctuation band, the derived estimates do not go beyond the limits of the band. However, allowing for a 95 percent confidence interval, the expected devaluation expectation could cross the limits on a few occasions. Nonetheless, Svensson (1993) maintains this is only a trivial problem. Figure 6 seems to depict slightly different estimates from Figure 5c in Svensson (1993), possibly because our expectations are for a month ahead whilst Svensson calculates the three-month expected devaluation rate and also because Svensson's estimation equation is different from equation (7). The daily expected realignment rate, y_t, are thus calculated by subtracting the expected future change in the exchange rate conditional upon no realignment, $\hat{x}_{t+m} - x_t$ (as always measured in percent deviation from central parity), from the corresponding interest rate differential, δ_t.

Figure 7 plots the resulting daily time series. Although the expected realignment rate follows the pattern of the interest rate differential plotted in Figure 3 (in particular at the beginning of the sample when the interest rate differential takes extreme values), they are not identical. In

[1] Moreover, the regression conducted without the quadratic and cubic terms provided inferior results in terms of parameter significance and goodness of fit.

the second half of the sample, especially, one may observe that the expected realignment rate often displays negative values and fluctuates slightly whilst the interest rate differential does not. The expected realignment rate is measured in percent per year and should be interpreted as the product of the expected realignment size times the expected realignment frequency. Hence, a value of 30 percent per annum indicates that a realignment of 5 percent (the average ERM realignment size) has an expected frequency of 6 per annum -or a 50 percent probability of occurrence in the next month.

The estimated expected realignment rate is often very high and volatile in the early 1980s and becomes small and stable after 1987. Figure 7 is clearly akin to Figure 8c in Svensson (1993), although the latter is for expectations three-months ahead. The decreasing pattern of the expected devaluation rate is still manifest in the plot of the monthly estimated realignment rate on Figure 8. As in Thomas (1994), Rose & Svensson (1994), Jeanne (1997), and Jeanne & Masson (1998), monthly estimates are obtained by averaging the daily observations over each month. The next step of our investigation is to model the estimated expected realignment rate time series, y_t, as a Markov regime switching process.

Figure 6: Expected FRF/DEM Exchange Rate Within the Band

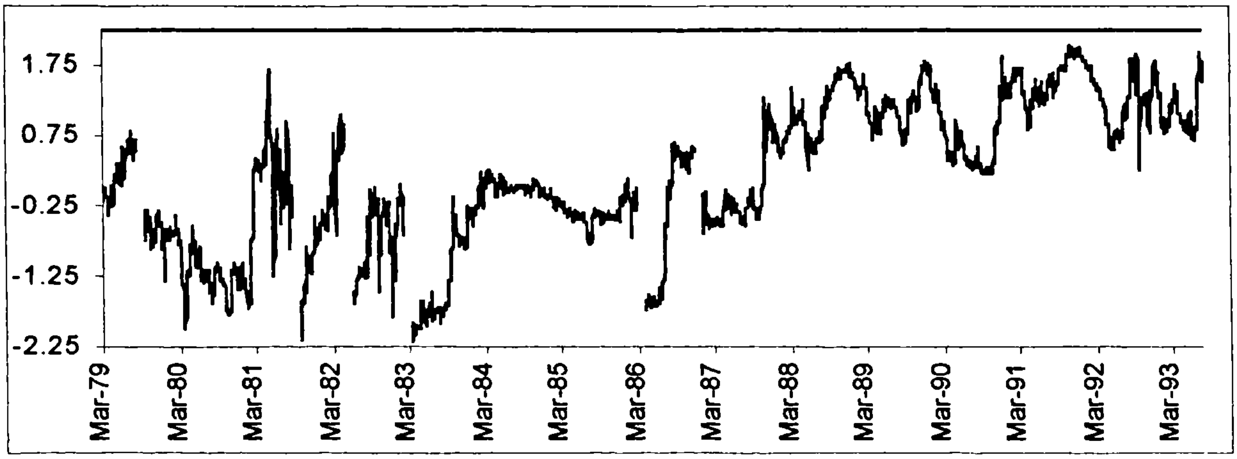
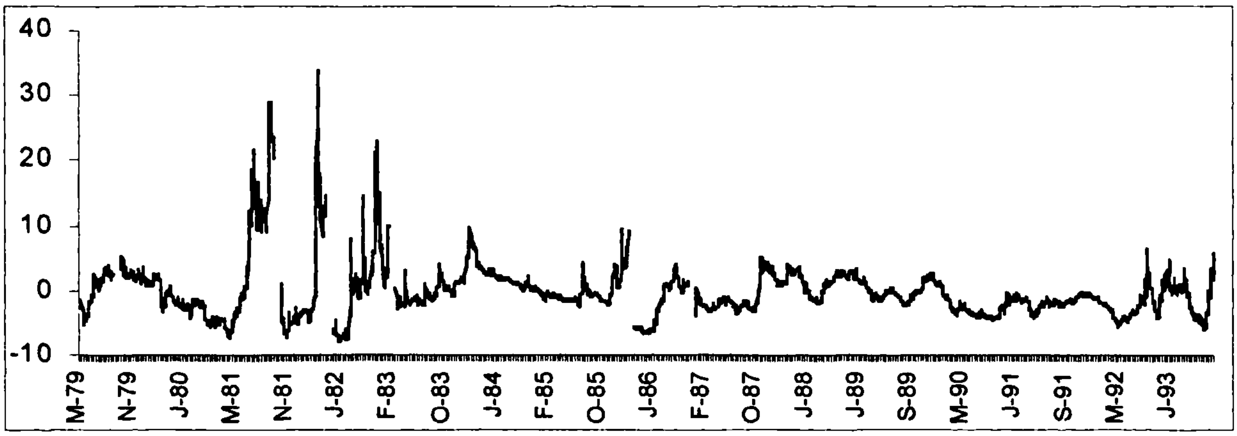


Figure 7: Daily Expected Realignment Rate for the FRF



6. 4. 2. Estimation of the Regime-Switching Model with Fixed Transition Probabilities

Table 2a provides the results of the static regime switching estimation with fixed transition probabilities. Two distinct regimes, one with low mean and low variance and the other with much higher mean and variance, are identified. The transition probabilities, p_{nn} and p_{cc}, show that the low mean-low variance state is more persistent than the high mean-high variance state. All coefficients are statistically significant. However, the tests presented in Table 2b suggest that severe specification problems are present. In particular there is evidence of autocorrelation in both states as well as heteroskedasticity. More importantly, the Andrews test given by Figure 9, shows that there is a permanent shift in the mean in the mid-1980s. Indeed the test statistic passes the 5 and 10 percent critical values at the end of 1985 and remains above them after January 1987.

This split in the process followed by the expected realignment rate -already apparent in the time series plotted on Figure 8- corresponds to a well-known characteristic of the ERM where fast convergence took off after the January 1987 realignment. Therefore, the sample period is divided in two: March 1979 until January 1987, and February 1987 until July 1993. OLS estimation of the expected movements within the band is conducted for the two sub-samples. It is found however that the estimates do not change significantly.

Table 3 gives the OLS results for the period 1979-1987. The dummies for regimes 2, 4, 5, and 7 are not statistically different from zero and those for regimes 3 and 6 are only significant at the 10 percent level. The current deviation of the exchange rate from the central parity and the interest rate differential are again statistically significant and have the same signs as in the full sample. The quadratic term becomes statistically significant at the 10 percent level whilst the cubic term is not statistically different from zero[2]. Overall the fit of the equation, with an R^2 of 42.87 percent, is not as good as that for the whole period. It is believed that the differences between the results for the two periods could be due to a small sample problem (the use of daily data does not eliminate the small sample problem because the data is highly persistent). In any case, however, Svensson (1993) points out that a poor fit is not itself a fundamental problem because the aim is to estimate the expected exchange rate within the band, not the actual exchange rate, and therefore the estimates cannot be perfect inasmuch as expectations are never perfectly accurate.

Figure 10 plots of the derived monthly realignment expectations for the period March 1979 to January 1987. The plot corresponds closely to that of Figure 8. Table 4a presents the results of the switching regime model estimation for this first sub-sample. Once more, there appears to be two distinct states: a state of low and stable realignment expectations and a state of volatile and high expectations. According to Table 4b, there is also evidence of autocorrelation and heteroskedasticity in this sample, although the LM test suggests that there is no autocorrelation in the crisis regime. The White test also reveals that there is no Markov specification problem.

Given that the static model is mis-specified, dynamic models were estimated. The first autoregressive coefficient proved to be the only significant autoregressive parameter. Table 4c therefore gives the results for an AR(1) specification. All parameters are statistically different from zero. The series is again characterised by two persistent regimes. The Box-Pierce Q statistics in Table 4d indicate that there remains some autocorrelation and heteroskedasticity in the series. However, it proved infeasible to get any better results with longer autoregressive processes. Finally, because it was suggested that state n was not autocorrelated, we allowed for the autoregressive coefficient to vary with the state. Table 4e reveals that the autoregressive

[2] The likelihood ratio test was computed and found equal to 80.62 (with zero p-value) so that the null hypothesis that the non-linear terms are not jointly statistically significant could be rejected.

parameter for regime c is not statistically different from zero. Therefore, another model -with autoregression in state n only- was estimated. Results are displayed in Table 4f.

In Table 4f, the normal state is depicted by a small mean associated with a low variance while the crisis state has much larger mean and variance. All the coefficients are statistically significant but the mean in the normal state. Although the specification has a higher mean squared errors (MSE=58.91) than the previous four models, it has the highest Schwarz criterion and lowest Turning Point (TP) statistic. The computed TP from the model (0.02021) is lower than the benchmark TP statistics ($\overline{TP}$=0.02316) which suggests that the model successfully predicts crises in-sample. The normal regime lasts approximately 20 months (as given by $D_n = 1/(1-p_{nn})$) and the crisis state 3 months.

Figure 11 provides a plot of the unconditional smoothed probabilities that the index was in the crisis state (or regime of high realignment expectations) at each date in the sample. A crisis period is defined as a month in which the smoothed probability of being in the crisis state is greater than 0.5[3]. Calculation of these probabilities uses the full sample (105 observations) and the maximum likelihood estimates of the parameter vector of the FTP model to draw an inference about the state of the index each month.

There are three crisis episodes thereby identified: May 1981 to September 1981; March 1982 to May 1982; and December 1982 to February 1983. It therefore appears that the foreign exchange market participants were expecting the May 1981 realignment for six months prior to the actual event. Likewise, the June 1982 realignment occurred against a background of high realignment expectations during the three previous months. Results also suggest that the expected realignment rate was very high for three months before the March 1983 realignment actually took place. The other ERM realignments do not seem to have been expected although one would expect the realignment of January 1987 to have happened in the context of high realignment expectations. Overall, it emerges that the regime switching technique provides an acceptable model for the expected realignment rate series. For lack of better results concerning autocorrelation and heteroskedasticity with alternative specifications, the model given in Table

[3] Since the values of the inferred probabilities are close to zero or one, the identification of crisis episodes does not change substantially when one chooses 0.6, 0.7 or 0.8 as a threshold.

4f is thus used as the foundation to investigate possible determinants of realignment expectations over the period from March 1979 to January 1987.

Table 5 presents the OLS estimates of expected future franc-mark exchange rate in the period from February 1987 to July 1993. As in the two samples previously studied, the parameter on the current deviation of the exchange rate from its central parity is positive and statistically significant and the coefficient on the interest rate differential is negative and significantly different from zero. The quadratic and cubic terms are not statistically significant but the likelihood ratio test for joint significance is equal to 19.97 (with p-value=7.86 e-06) and we reject the null that the non-linear terms are jointly statistically insignificant. The goodness of fit of the equation (adjusted R^2=54.08 percent) is slightly better than for the 1979-1987 sample but not as good as for the whole sample.

The resulting monthly expected realignment rate is plotted in Figure 12. The plot is practically identical to that derived from the full sample (Figure 8). In Figure 12, one can observe that the expected realignment rate is positive and volatile until the beginning of 1990, then becomes negative and relatively stable, before returning to positive values in the Autumn of 1992.

Results of the static regime switching model with fixed transition probabilities are given in Table 6a. The expected realignment rate is characterised by a stable regime with a negative mean and low variance, and a crisis state depicted by a larger positive mean and a larger variance. Both regimes are highly persistent (note that it goes against intuition that the normal state should last less than the crisis regime) and all the parameters are statistically significant. Table 6b however reveals that the model is subject to an autocorrelation problems. Therefore, dynamic specifications were tried. The first three autoregressive coefficients proved statistically different from zero and the AR(1) and AR(2) specifications still displayed autocorrelation problems.

Results of the estimation of an AR(3) model are presented in Table 6c. The model associates the normal regime with a positive mean realignment expectation and a small variance, and the crisis state with a larger mean and higher variance. All coefficients are statistically different from zero but the mean in the normal state. The average length of stay in the normal state is 29 months, while that in the crisis regime is seven months. According to the Box-Pierce Q-statistics in Table 6d, the AR(3) model does not have any omitted autocorrelation or heteroskedasticity. The Turning Point statistic is lower, and the Schwarz Criterion is much higher, than in the static model. The computed TP from the model (0.1661) is slightly higher than the benchmark TP statistics ($\overline{TP}$=0.1154) which suggests that the model overpredicts the number of crises.

Figure 13 draws the inferred unconditional smoothed probabilities of being in the regime of high and volatile realignment expectations. Two episodes only fall into this category: November 1987 and September 1992 until July 1993. In fact, the identification is closely related to the actual events over the period. Indeed, the late 1980s and very early 1990s are commonly perceived as a tranquil era for the ERM and the franc in particular. On the other hand, there clearly was a wave of high speculative pressure against the franc in November 1987 as well as in the Autumn of 1992 until the Summer of 1993. Therefore, the model given in Table 6c is extended to time-varying probabilities to investigate the factors that influence realignment expectations.

Note that a comparison of Tables 4f and 6c confirms the importance of the shift in the patterns followed by the expected realignment rate between the two periods. Indeed, expected devaluations in the normal state are much higher and volatile in the first sub-sample than in the second. Likewise, whilst realignment expectations are very high and volatile in the crisis regime in the early 1980s, they become smaller and less volatile in the late 1980s and early 1990s. This remark is in accordance with Rose & Svensson's (1994) proposition that ERM exchange arrangements clearly lacked perfect credibility as realignment expectations were typically non-negligible throughout the ERM period. Our results also conform to Svensson's (1993) comment that although realignment expectations decreased over time, they remained positive as late as 1992.

Table 1: Estimation of the Future FRF/DEM Rate Within the Band: 79M03–93M07

Method: Least Squares
Sample: 1 3514
Included observations: 13.03.79 – 30.07.93
Newey-West HAC Standard Errors & Covariance (lag truncation=8)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
x_t	0.767942	0.081083	9.471025	4.935e-21
x_t^2	-0.032450	0.027661	-1.173102	0.240834
x_t^3	-0.020680	0.022520	-0.918318	0.358515
δ_t	-1.011187	0.270128	-3.743359	0.000184
α_1: 13.03.79	0.433510	0.163361	2.653688	0.007997
α_2: 24.29.79	0.145033	0.135908	1.067137	0.285983
α_3: 05.10.81	0.566588	0.315879	1.793688	0.072949
α_4: 14.06.82	0.681457	0.285221	2.389220	0.016936
α_5: 21.03.83	0.402586	0.142663	2.821934	0.004800
α_6: 07.04.86	0.296827	0.156223	1.900014	0.057513
α_7: 12.01.87	0.516817	0.091667	5.637956	1.856929e-08

R-squared	0.768725	Mean dependent var	0.1479919
Adjusted R-squared	0.767783	S.D. dependent var	1.1565159
S.E. of regression	0.666598	Akaike info criterion	2.0298683
Sum squared resid	1556.571	Schwarz criterion	2.0491653
Log likelihood	-3555.478	F-statistic	707.1319366
Durbin-Watson stat	0.093504	Prob(F-statistic)	0

Table 2a: Fixed Transition Probabilities Model: 1979 M03 – 1993M07

μ_n	μ_c	σ_n^2	σ_c^2	p_{nn} (%)	p_{cc} (%)	Lik./SC	MSE	TP
1.9316*	17.91*	13.227*	78.274*	97.17*	76.65*	-349.79	17.1596	.1906
[6.352]	[6.335]	[8.049]	[2.815]	[6.792]	[7.415]	-365.25		

(*) denotes significance at the 5 percent level. Numbers in square brackets below the parameter estimates are t-statistics.

Table 2b: Specification Tests for the Static Model

White test F(4, 167)		**LM Tests** F(1, 168)	
Serial Correlation in both regimes	26.5*	Serial Correlation in regime n	104.3*
ARCH effects in both regimes	6.37*	Serial Correlation in regime c	6.80*
Markov Specification	2.24	Serial Correlation across regimes	100.6*
		ARCH effects in both regimes	25.24*

The 5 percent critical values for the F(4, 167) and F(1, 168) are 2.38 and 3.85 respectively; and the 1 percent critical values are 3.34 and 6.66 respectively. (*) denotes significance at the 1 percent level; (**)denotes significance at the 5 percent level

Table 3: Estimation of the Future FRF/DEM Rate Within the Band: 1979M03–1987M01

Sample: 1 1863 Included observations: 13.03.79 – 12.01.87 Newey-West HAC Standard Errors & Covariance (lag truncation=7)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
x_t	0.700087	0.134182	5.217432	0.0000
x_t^2	-0.172171	0.092118	-1.869035	0.0618
x_t^3	-0.066276	0.047961	-1.381873	0.1672
δ_t	-0.662074	0.333696	-1.984063	0.0474
α_1: 13.03.79	0.374739	0.159119	2.355078	0.0186
α_2: 24.29.79	0.137396	0.167935	0.818147	0.4134
α_3: 05.10.81	0.548455	0.313989	1.746734	0.0808
α_4: 14.06.82	0.396682	0.341911	1.160193	0.2461
α_5: 21.03.83	0.238553	0.179401	1.329714	0.1838
α_6: 07.04.86	0.267262	0.151900	1.759462	0.0787
α_7: 12.01.87	-0.132606	0.157200	-0.843551	0.3990

R-squared	0.428722	Mean dependent var	-0.533517
Adjusted R-squared	0.425637	S.D. dependent var	0.978578
S.E. of regression	0.741632	Akaike info criterion	2.245959
Sum squared resid	1018.633	Schwarz criterion	2.278610
Log likelihood	-2081.111	F-statistic	138.9855
Durbin-Watson stat	0.103456	Prob(F-statistic)	0.000000

Table 4a: Fixed Transition Probabilities Model: 1979 M03 – 1987M01

μ_n	μ_c	σ_n^2	σ_c^2	p_{nn} (%)	p_{cc} (%)	Lik./SC	MSE	TP
3.467*	24.83*	18.427*	75.79**	96.23*	72.8*	-212.2	33.6308	0.2086
[6.731]	[6.859]	[5.796]	[1.883]	[4.39]	[5.536]	-226.2		

(*) denotes significance at the 5 percent level.

Table 4b: Specification Tests for the Static Model

White test F(4, 99)		**LM Tests** F(1, 100)	
Serial Correlation in both regimes	14.530*	Serial Correlation in regime n	53.273*
ARCH effects in both regimes	6.053*	Serial Correlation in regime c	2.907
Markov Specification	.2488	Serial Correlation across regimes	38.201*
		ARCH effects in both regimes	21.146*

The 5 percent critical values for the F(4, 99) and F(1, 100) are 2.48 and 3.95 respectively; and the 1 percent critical values are 3.54 and 6.93 respectively. (*) denotes significance at the 1 percent level; (**)denotes significance at the 5 percent level.

Table 4c: AR(1) Model with ρ Constant Across States

μ_n	μ_c	ρ_n	σ_n^2	σ_c^2	p_{nn} (%)	p_{cc} (%)	Lik./SC	MSE	TP
4.735*	16.63*	.8582*	3.682*	157.2*	97.43*	90.72*	-167.3	57.77	0.2608
[2.76]	[6.38]	[14.69]	[5.83]	[3.36]	[5.35]	[15.7]	-183.6		

Table 4d: Box-Pierce Q-statistics on Residuals for Autocorrelation (A) and Heteroskedasticity (H)

	Q(1)	Q(2)	Q(3)	Q(4)	Q(5)	Q(6)	Q(7)	Q(8)	Q(9)	Q(10)	Q(20)
A	.1775 [.673]	5.238 [.073]	5.963 [.113]	5.975 [.201]	17.7* [.003]	21.4* [.001]	22.3* [.002]	33.4* [.000]	34.5* [.000]	35.0* [.000]	40.8* [.004]
H	.0238 [.877]	1.893 [.388]	3.111 [.375]	3.407 [.492]	16.6* [.005]	16.9* [.009]	16.9* [.018]	25.8* [.001]	25.8* [.002]	26.6* [.003]	29.08 [.086]

$\chi^2(m)$ tests. *p*-values in square brackets. (*) denotes significance at the 5 percent level

Table 4e: AR(1) Model with ρ Dependent on State

μ_n	μ_c	ρ_n	ρ_c	σ_n^2	σ_c^2	p_{nn} (%)	p_{cc} (%)	Lik./ SC	MSE	TP
1.476 [1.33]	22.616 [6.97]	.938* [16.6]	-.070 [-.78]	4.15* [5.85]	111.6* [2.97]	95.12* [2.55]	68.43* [14.2]	-157.6 -176.2	57.25	0.2014

(*) denotes significance at the 5 percent level

Table 4f: AR(1) Process in State n Only

μ_n	μ_c	ρ_n	σ_n^2	σ_c^2	p_{nn} (%)	p_{cc} (%)	Lik./SC	MSE	TP
1.346 [1.20]	22.76* [6.60]	.9405* [16.53]	4.216* [5.79]	107.7* [2.36]	95.12* [2.610]	68.62* [14.28]	-157.86 -174.15	58.91	0.2011

Table 5: Estimation of the Future FRF/DEM Rate Within the Band: 1987M02-1993M07

Sample: 1864 3514				
Included observations: 13.01.87 – 30.07.93				
Newey-West HAC Standard Errors & Covariance (lag truncation=7)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
x_t	0.758735	0.095078	7.980121	0.0000
x_t^2	-0.056363	0.160860	-0.350387	0.7261
x_t^3	0.029147	0.084512	0.344888	0.7302
δ_t	-0.895949	0.281900	-3.178248	0.0015
α_7: 12.01.87	0.452953	0.091628	4.943411	0.0000
R-squared	0.541958	Mean dependent var		0.917012
Adjusted R-squared	0.540845	S.D. dependent var		0.806788
S.E. of regression	0.546688	Akaike info criterion		1.633146
Sum squared resid	491.9360	Schwarz criterion		1.649528
Log likelihood	-1343.162	F-statistic		486.8886
Durbin-Watson stat	0.073118	Prob(F-statistic)		0.000000

Table 6a: Fixed Transition Probabilities Model: 1987M02-1993M07

μ_n	μ_c	σ_n^2	σ_c^2	p_{nn} (%)	p_{cc} (%)	Lik./SC	MSE	TP
-1.196*	3.282*	2.396*	5.3425*	94.91*	96.06*	-102.03	3.8517	0.2431
[-4.13]	[9.09]	[3.78]	[4.58]	[24.36]	[32.34]	-115.10		

(*) denotes significance at the 5 percent level.

Table 6b: Specification Tests for the Static Model

White test F(4, 72)		**LM Tests** F(1, 73)	
Serial Correlation in both regimes	4.223*	Serial Correlation in regime n	5.6349**
ARCH effects in both regimes	1.162	Serial Correlation in regime c	12.647*
Markov Specification	5.14**	Serial Correlation across regimes	18.154*
		ARCH effects in both regimes	4.0681

The 5 percent critical values for the F(4, 72) and F(1, 73) are 2.51 and 3.98 respectively; and the 1 percent critical values are 3.62 and 7.04 respectively. (*) denotes significance at the 1 percent level; (**)denotes significance at the 5 percent level.

Table 6c: Results from the Estimation of the AR(3) FTP Model

μ_n	μ_c	ρ_1	ρ_2	ρ_3	σ_n^2	σ_c^2	p_{nn} (%)	p_{cc} (%)	Lik. S.C.	MSE	TP
.3384	2.7**	1.38*	-.813*	.328*	.906*	12.3*	96.6*	86.5*	-61.64	3.852	0.166
[.267]	[1.90]	[13.2]	[-4.9]	[3.22]	[5.39]	[2.36]	[3.80]	[7.04]	-81.25		

Table 6d: Box-Pierce Q-statistics on Residuals for Autocorrelation (A) and Heteroskedasticity (H)

	Q(1)	Q(2)	Q(3)	Q(4)	Q(5)	Q(6)	Q(7)	Q(8)	Q(9)	Q(10)	Q(20)
A	.0059 [.939]	.2912 [.864]	1.889 [.596]	3.436 [.488]	3.705 [.593]	3.867 [.695]	6.098 [.528]	7.252 [.509]	7.420 [.593]	8.033 [.626]	19.69 [.477]
H	.0600 [.806]	.2344 [.889]	.2531 [.969]	.3922 [.983]	.4540 [.994]	.4913 [.998]	.5645 [.999]	.5916 [.999]	.5975 [.999]	.5987 [1.00]	.8423 [1.00]

$\chi^2(m)$ tests. p-values in square brackets. (*) denotes significance at the 5 percent level

Figure 8: Monthly Realignment Expectations for the Franc

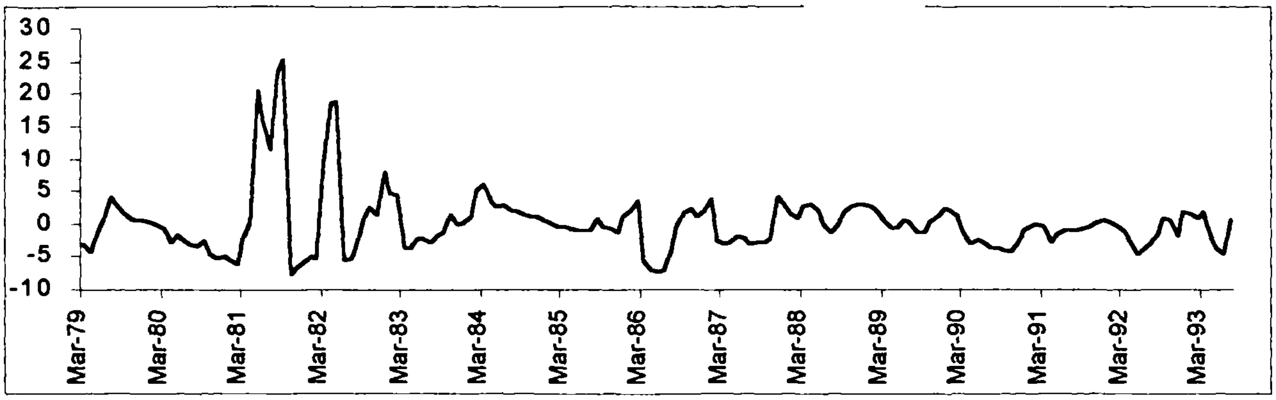


Figure 9: Andrews'Test for Permanent Shift in the Mean

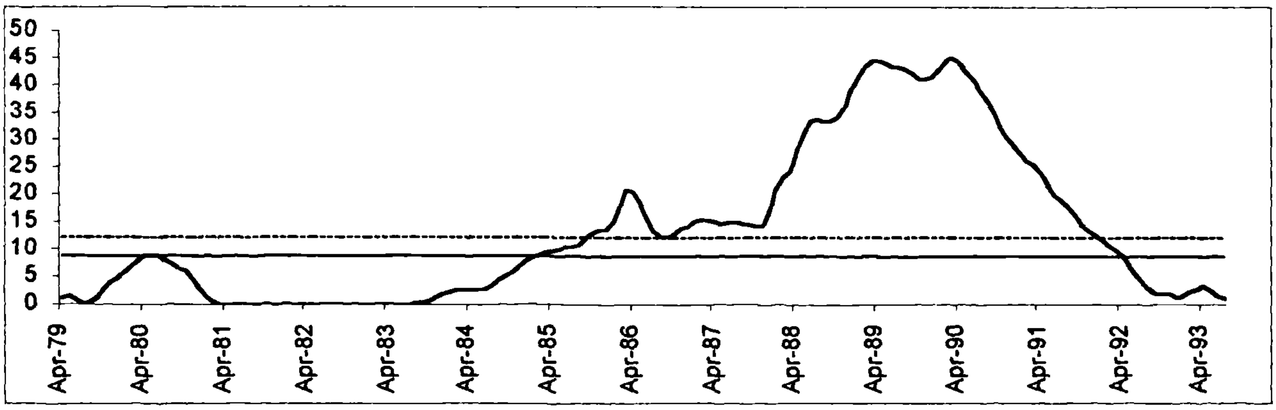


Figure 10: Monthly Realignment for the FRF: 1979M03-1987M01

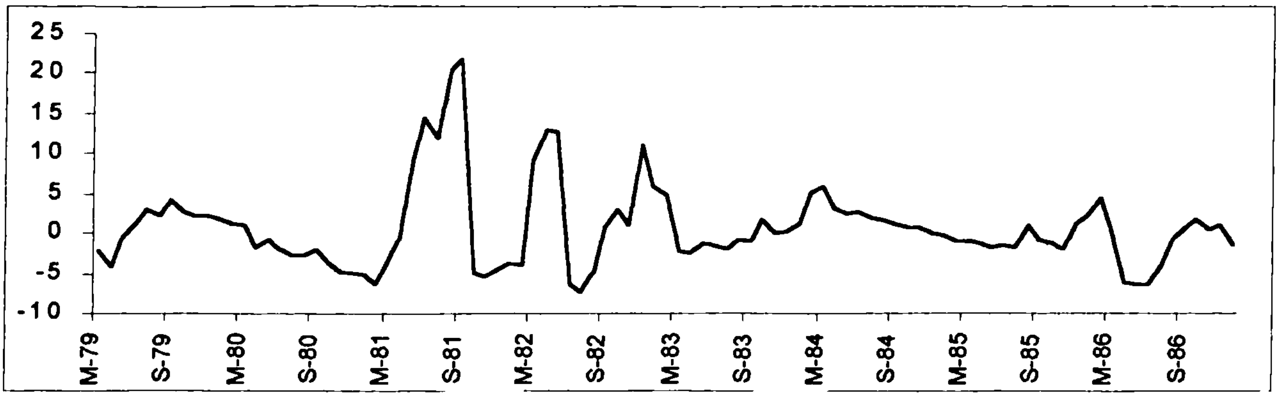


Figure 11: Smoothed Probabilities of Being in State c -AR(1) in state n only- 79-87

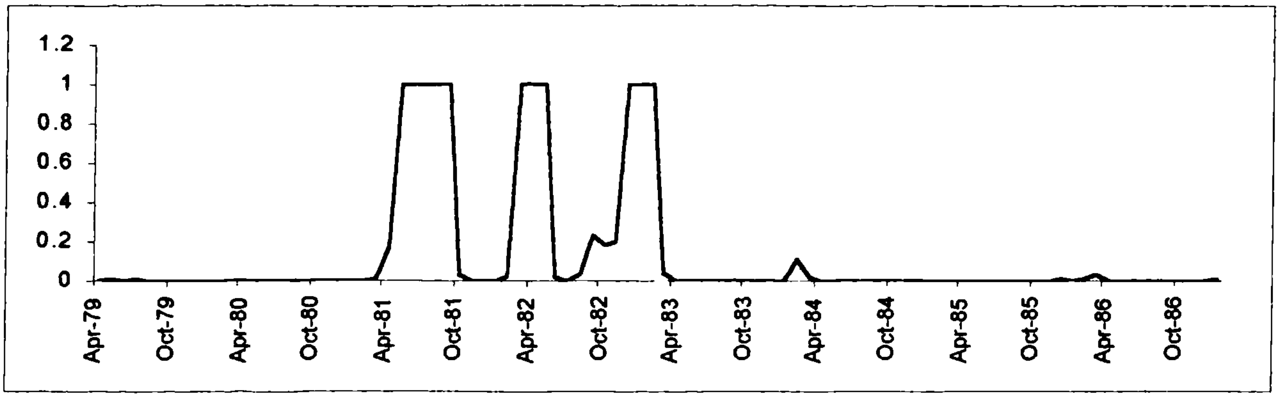


Figure 12: Monthly Realignment Rate for the FRF: 1987M02-1993M07

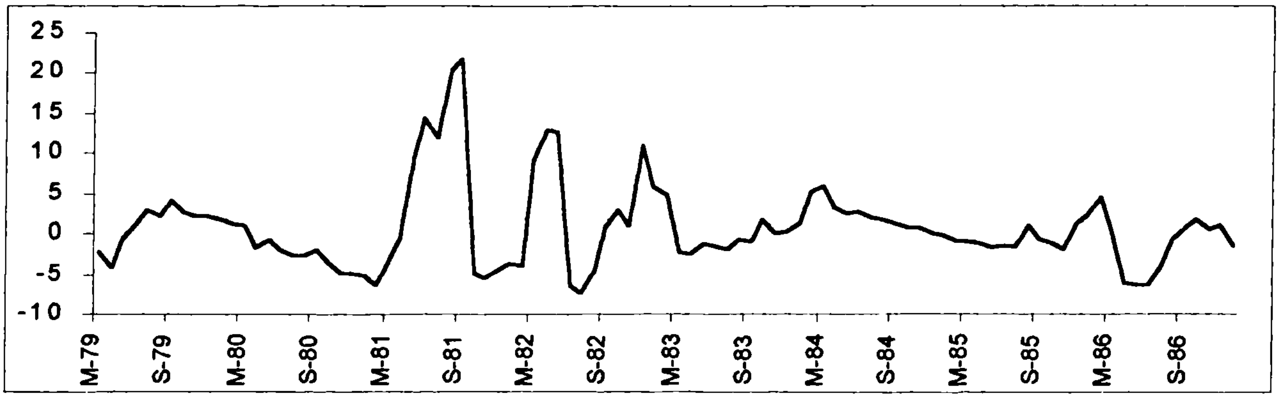
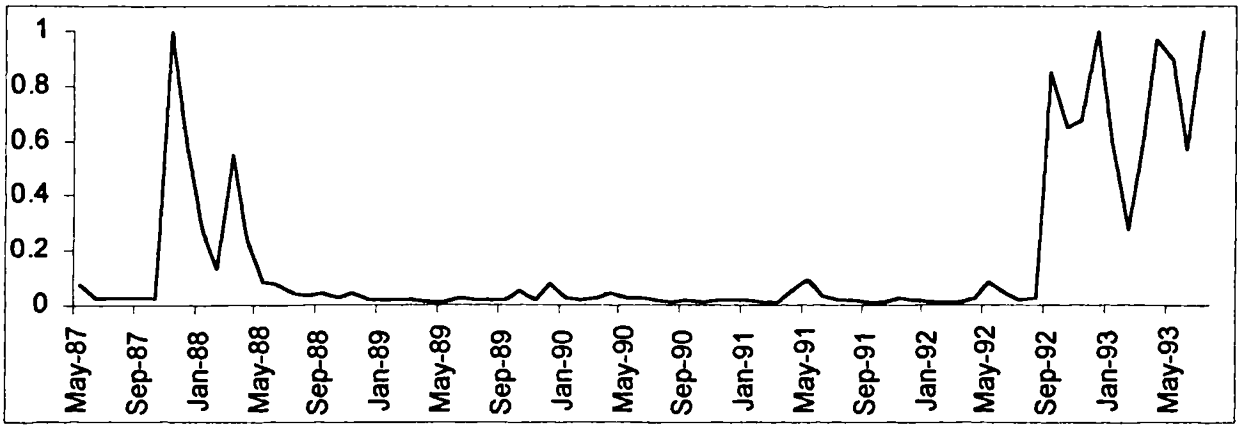


Figure 13: Smoothed Probabilities of Being in State c -AR(3) Model- 87-93



6. 4. 3. Time-Varying Transition Probabilities: The Role Economic Variables

A. Sample 1979M03 – 1987M01

Tables 7 to 12 present the inference on the effects of various indicators (current and lagged, domestic and differential, economic and external variables) on realignment expectations regarding the franc. Numbers in square brackets below the parameter estimates are t-statistics. It is commonly found in all tables that the mean in the crisis regime, μ_c, the autoregressive term, ρ_n, and the variance in each regime (σ_n^2 and σ_c^2) are statistically significant and similar to the estimates of the fixed transition probability model of Table 4f. Besides, the fixed parameter for the transition probabilities from the normal state, δ_n^0, is statistically significant and positive, confirming that once realignment expectations are in the normal state, the probability that they will remain in that state is high[4]. The fixed parameter for the transition probabilities from the crisis regime, δ_c^0, by contrast, is not often statistically different from zero.

[4] Exceptions include the cases of DEBT in Tables 7 and 9, the M2 to reserves differential ratio in Tables 8, 10, and 12, and the European average level of credibility in Tables 13 to 15.

Table 7 presents the results for the French current economic variables and German mark depreciation rate. None of the explanatory variables is both statistically significant and theoretically consistent. Although the change in the real exchange rate, ΔRER, and in the dollar-mark exchange rate, ΔDM$, are statistically significant in the crisis state, their signs are not as theoretically anticipated. Conversely, although the change in inflation, ΔINF, and the trade balance, TB, have the correct signs in both the normal and crisis regimes, the parameters are not statistically different from zero. Likewise, some variables have the expected signs in the normal regime (the change in industrial production, ΔIP; the change in the real exchange rate, ΔRER; the ratio of M2 to reserves, M2/R; and the change in real GDP, ΔGDP and in the crisis state (the change in the unemployment rate, ΔUR), but the coefficients are not statistically different from zero. Finally, the other indicators are statistically insignificant and theoretically inconsistent (DEBT, M2/R and ΔDM$ in the normal regime, DEBT, ΔIP, ΔRER, M2/R, and ΔGDP in the crisis state).

Table 8 summarises the results for the current differentials between French and German variables. The only indicator that is statistically significant and displays the correct sign is the inflation rate differential, ΔINFD, in the crisis regime. When the inflation differential between France and Germany exceeds -0.107 percent, the probability of staying in the regime of high devaluation expectations, p_{cc}, is higher than 0.5. This is a low trigger value that ΔINFD often passes (see Figure F11 in Appendix 4.1). Figure 14a plots p_{cc} with ΔINFD as forcing variable. Clearly, p_{cc} is extremely unstable. Yet, it can be verified that during the three crisis periods identified by the unconditional smoothed probabilities in Figure 11 (81M05-81M09, 82M03-82M05 and 82M12-83M02), the conditional probability of remaining in the crisis regime is close to 1. The parameter on ΔINFD in the regime of low devaluation expectations has the theoretically correct sign but it is not significantly different from zero. This is also the case for ΔRERD, TBD, and M2/RD. Other variables are correctly signed but are not statistically different from zero (IPD and ΔGDP in both states, as well as DEBTD, and ΔURD in the crisis regime). Finally, the remaining differentials (DEBTD and ΔURD in the normal state, and ΔRERD, TBD and M2/RD in the regime of crisis) are statistically insignificant and theoretically inconsistent.

Table 9 displays the findings on the one-month-lagged French variables and the German mark depreciation rate. Two indicators are correctly signed and statistically significant: ΔINF in the crisis state[1] and ΔGDP in the normal regime. This means that the higher ΔINF, the higher p_{cc}. In particular, if ΔINF exceeds -0.016 percent, the p_{cc} crosses the 0.5 threshold. Examining the plot of ΔINF in Figure F2 (Appendix 4.1.), one can readily observe that the trigger value is passed in several periods. This explains why p_{cc} in Figure 14b is highly volatile (especially in the first half of the sample) before it falls to lower level from 1984 onwards. Again, p_{cc} turns out to be close to one during the three crisis episodes previously identified. Additionally, the higher the one-month-lagged GDP growth rate, the more likely it is that realignment expectations will remain low and stable. The conditional probability of remaining in the normal state, p_{nn}, with explanatory variable ΔGDP is plotted in Figure 14c. The plot shows that p_{nn} is very stable and close to one for most of the period. Indeed, as long as ΔGDP exceeds -0.146 percent -which is the case during most of the period according to Figure F8 in Appendix 4.1- p_{nn} is greater than 0.5 (there are however four exceptions: 82M09, 84M08, 86M02 and 86M07). TB has the expected signs in both regimes but its parameters are not statistically significant. Other indicators are correctly signed but are statistically insignificant (ΔIP, ΔRER, M2/R and ΔDM$ in the normal state and ΔUR in the crisis state). Finally, the remaining indicators are statistically insignificant and display the wrong signs: DEBT in both states, ΔINF and ΔUR in the normal regime, ΔIP, ΔRER, M2/R and ΔDM$ in the crisis state.

Table 10 presents the results on the explanatory power of one-month-lagged differentials between French and German indicators. None of the proposed indicators is both theoretically consistent and statistically significant. DEBTD is statistically significant at the 10 percent level in the crisis state but its sign is not theoretically correct. Although IPD and M2/RD have the expected signs in the two regimes, the parameters are not statistically different from zero. Likewise the other correctly signed indicators (TBD and ΔGDPD in the normal state, ΔINFD and ΔURD in the crisis regime) are not statistically significant. Lastly, the remaining parameters are inconsistent in economic terms and statistically insignificant (DEBTD, ΔINFD, ΔRERD, ΔURD in the normal regime and ΔRERD, TBD and ΔGDPD).

[1] Note that ΔINF is only significant at the 10 percent level.

Table 11 shows the estimation results using the two-month-lagged French economic variables and German mark depreciation rate. Two indicators -ΔRER and TB- prove statistically significant and theoretically consistent (although the parameters are only significant at the 10 percent level) in determining switches from the normal state. As long as ΔRER is lower than 9.74 percent, p_{nn} remains above the 0.5 threshold. In like manner, a value of TB above -0.3205 ensures that p_{nn} is higher than 0.5. Figures 14d and 14e plot p_{nn} for ΔRER and TB, respectively. The two plots suggest that p_{nn} is stable and close to one for the whole period despite a few modest plunges (it never falls below sixty percent). This is because ΔRER never exceeds- and TB never is smaller than- their respective trigger value (see Figures F4 and F5 in Appendix 4.1). Four other indicators are statistically significant: ΔINF, ΔIP and ΔGDP in the normal regime and ΔDM$ in the crisis state. However, the signs of the corresponding coefficients are not as theoretically anticipated. On the other hand, some indicators are correctly signed but are not statistically different from zero (ΔUR in both regimes, M2/R in the normal state and TB in the crisis state). Finally, the remaining two-month-lagged variables are both theoretically inconsistent and statistically insignificant (DEBT in both regimes, ΔINF, ΔIP, ΔRER, M2/R and ΔGDP in the crisis state).

Table 12 summarises the findings on two-month-lagged differentials between the French and German indicators. Again, two indicators display the theoretically anticipated signs and are statistically significant: ΔRERD and TBD in the normal regime. In words, the lower the two-month-lagged real exchange rate differential and the higher the trade balance, the more likely it is that devaluation expectations will remain low and stable. Figures 14f and 14g plot p_{nn} for two-month-lagged ΔRERD and ΔTBD, respectively. Clearly, the conclusions are akin to those drawn from Figures 14d and 14e, i.e. the transition probabilities are very stable and high during the entire period for both variables. As in the case of ΔRER and TB -the trigger values: -4.03 percent for ΔRERD and -0.452 for TBD- are never reached (see Figures F13 and F14 in Appendix 4.1.). ΔINFD in the normal regime and DEBTD in the crisis state are also statistically significant but they do not have the expected signs. Conversely, some indicators are correctly signed -M2/RD and ΔURD in both states and ΔRERD in the crisis regime- but the coefficients are not statistically different from zero. The rest of the two-month-lagged differentials are neither statistically significant nor theoretically consistent. These include DEBTD[2], IPD and ΔGDPD in both regimes, ΔINFD and TBD in the crisis state.

[2] In Thomas (1994) the relationship between devaluation expectations and the relative debt to GDP ratio is also insignificant for France.

Table 7: Z_t **= Current French Variables and External Variable**

	DEBT	ΔINF	ΔIP	ΔRER	TB	M2/R	ΔUR	ΔGDP	ΔDM$
μ_n	1.3378 [1.276]	1.3911 [1.252]	1.3454 [1.245]	1.2859 [1.226]	1.3189 [1.246]	1.3836 [1.285]	1.3676 [1.253]	1.3429 [1.248]	1.3193 [1.23]
μ_c	22.56* [6.715]	23.53* [7.896]	22.77* [6.636]	21.79* [6.558]	22.09* [6.360]	23.32* [8.051]	23.07* [7.153]	22.73* [6.578]	22.23* [6.40]
ρ_n	.9408* [17.44]	.9414* [17.27]	.9407* [17.28]	.9400* [16.62]	.9396* [17.23]	.9417* [17.35]	.9417* [17.33]	.9408* [17.09]	.9398* [17.2]
σ_n^2	4.165* [11.44]	4.333* [11.98]	4.217* [11.46]	4.014* [11.29]	4.087* [10.83]	4.319* [12.16]	4.265* [11.64]	4.214* [11.45]	4.107* [11.9]
σ_c^2	108.9* [5.165]	102.4* [4.675]	107.9* [4.877]	112.6* [5.169]	111.6* [5.297]	104.3* [4.743]	106.2* [4.769]	108.2* [4.950]	110.6* [5.06]
δ_n^0	1.8469 [1.483]	2.947* [5.877]	2.968* [6.104]	3.980* [3.759]	3.640* [3.508]	3.52** [1.945]	2.727* [3.245]	2.969* [6.045]	3.011* [5.99]
δ_n^1	7.3131 [.897]	-.3559 [-.247]	.0092 [.024]	-.303 [-1.35]	6.3095 [.800]	-.6712 [-.317]	.4253 [.339]	.7119 [.095]	-.0937 [-.503]
δ_c^0	3.72** [1.691]	.7283 [1.195]	.7158 [1.138]	2.951* [2.068]	.3461 [.229]	4.2097 [1.487]	-.2890 [-.261]	.7169 [.630]	1.2502 [1.59]
δ_c^1	-21.18 [-1.40]	3.3994 [1.616]	.3441 [.411]	-.458** [-1.81]	-3.8559 [-.357]	-4.1763 [-1.27]	1.4509 [1.086]	5.8238 [.403]	.421** [1.80]
Lik.	-156.41	-156.49	-157.78	-155.22	-157.51	-157.02	-157.21	-157.78	-155.5
MSE	63.075	68.072	64.452	61.519	60.603	66.823	65.376	64.258	62.422
TP	.20726	.21740	.20879	.21237	.19746	.20206	.21247	.20845	.20597

Table 8: Z_t**=Current Differences in French and German Variables**

	DEBTD	ΔINFD	IPD	ΔRERD	TBD	M2/RD	ΔURD	ΔGDPD
μ_n	1.3357 [1.254]	1.4071 [1.257]	1.3715 [1.255]	1.3689 [1.266]	1.3625 [1.252]	1.3772 [1.253]	1.3604 [1.265]	1.3691 [1.279]
μ_c	22.511* [6.713]	23.655* [8.060]	23.122* [7.083]	23.111* [6.992]	23.063* [7.012]	23.247* [7.673]	23.042* [7.091]	23.102* [6.913]
ρ_n	.9408* [18.16]	.9401* [18.03]	.9406* [17.32]	.9406* [16.59]	.9399* [16.97]	.9415* [17.08]	.9412* [17.14]	.9407* [17.20]
σ_n^2	4.1584* [11.30]	4.3401* [12.22]	4.2805* [11.97]	4.2656* [11.94]	4.2709* [11.65]	4.3111* [11.88]	4.2665* [11.64]	4.2756* [11.631]
σ_c^2	109.36 [4.824]	100.45* [4.821]	105.17* [4.893]	104.89* [4.892]	105.54* [5.025]	104.89* [4.849]	105.94* [4.880]	105.28* [5.188]
δ_n^0	3.6015* [4.192]	3.007* [5.926]	2.9858* [6.116]	2.9905* [6.005]	4.6755* [2.872]	2.5862 [1.487]	2.7647* [3.879]	2.9845* [6.119]
δ_n^1	2.3329 [1.260]	-1.0781 [-1.038]	.0189 [.083]	-.1768 [-.451]	7.4728 [1.126]	-.4769 [-.238]	.1873 [.387]	.3141 [.063]
δ_c^0	-.4537 [-.423]	1.0403 [1.035]	.9582 [1.416]	.8608 [1.316]	2.1602 [.962]	-2.0314 [-.609]	.4373 [.554]	.9485 [1.464]
δ_c^1	-3.8040 [-1.406]	9.718** [1.813]	-.6538 [-.965]	-.4137 [-.693]	5.6019 [.642]	-3.6689 [-.854]	.3512 [.647]	-11.146 [-.875]
Lik.	-156.08	-153.62	-157.34	-157.53	-157.05	-157.50	-157.61	-157.46
MSE	62.8117	69.0774	65.7621	65.7948	65.4559	66.4439	65.2778	65.6173
TP	.206207	.219897	.210625	.21269	.20723	.21045	.209732	.210408

Table 9: Z_t = Lagged French Variables and External Variable (1 lag)

	DEBT	ΔINF	ΔIP	ΔRER	TB	M2/R	ΔUR	ΔGDP	ΔDM$
μ_n	1.4616 [1.497]	1.53** [1.663]	1.3454 [1.245]	1.3749 [1.528]	1.3189 [1.246]	1.4805 [1.458]	1.3676 [1.252]	1.3562 [1.561]	1.480 [1.44]
μ_c	22.56* [6.651]	23.82* [8.384]	22.77* [6.636]	21.14* [6.616]	22.09* [6.360]	22.93* [6.599]	23.06* [7.153]	20.55* [7.557]	22.89* [6.64]
ρ_n	.9399* [16.45]	.9381* [16.56]	.9407* [17.28]	.9381* [19.22]	.9396* [17.23]	.9395* [16.77]	.9417* [17.33]	.9451* [17.91]	.9383* [16.6]
σ_n^2	4.054* [10.97]	4.267* [12.06]	4.217* [11.46]	3.776* [9.619]	4.087* [10.83]	4.150* [11.19]	4.265* [11.64]	3.638* [12.22]	4.129* [11.2]
σ_c^2	108.5* [5.032]	98.32* [4.769]	107.9* [4.877]	115.5* [5.284]	111.6* [5.297]	106.2* [4.897]	106.2* [4.769]	119.8* [5.976]	106.3* [4.82]
δ_n^0	1.6016 [1.376]	3.095* [5.487]	2.968* [6.104]	3.692* [3.588]	3.640* [3.508]	3.49** [1.860]	2.727* [3.245]	7.343* [2.475]	2.877* [6.15]
δ_n^1	8.3014 [1.066]	1.1569 [1.113]	.0092 [.024]	-.2530 [-1.10]	6.3095 [.800]	-.7649 [-.344]	.4253 [.339]	50.29* [2.197]	.0285 [.154]
δ_c^0	4.60** [1.900]	.1412 [.156]	.7158 [1.138]	2.162* [1.965]	.3461 [.2289]	1.2122 [1.074]	-.2890 [-.261]	1.11** [1.677]	.6149 [.933]
δ_c^1	-29.17 [-1.57]	8.50** [1.760]	.3441 [.411]	-.3310 [-1.45]	-3.8559 [-.357]	-.5639 [-.392]	1.4509 [1.086]	-11.261 [-.980]	.2354 [.992]
Lik.	-153.91	-152.84	-157.78	-154.66	-157.51	-156.04	-157.21	-149.81	-155.5
Mse	63.437	70.367	64.452	59.977	60.603	65.319	65.376	68.658	65.631
TP	.20296	.20858	.20879	.19611	.19746	.20346	.21247	.17092	.21553

Table 10: Z_t=Lagged Differences Between French and German Variables (1 lag)

	DEBTD	ΔINFD	IPD	ΔRERD	TBD	M2/RD	ΔURD	ΔGDPD
μ_n	1.4499 [1.495]	1.5128 [1.406]	1.3715 [1.255]	1.4072 [1.488]	1.3625 [1.252]	1.4549 [1.471]	1.3604 [1.265]	1.4715 [1.493]
μ_c	22.503* [6.570]	23.661* [8.020]	23.122* [7.083]	21.267* [7.453]	23.063* [16.97]	22.349* [6.222]	23.042* [7.091]	22.465* [6.562]
ρ_n	.9400* [17.36]	.9381* [16.39]	.9406* [17.32]	.9311* [15.66]	.9399* [16.97]	.9385* [16.78]	.9412* [17.14]	.9365* [16.38]
σ_n^2	4.0498* [10.53]	4.2702* [12.18]	4.2805* [11.97]	3.7334* [10.65]	4.2709* [11.65]	4.0213* [10.31]	4.2665* [11.64]	4.0302* [10.83]
σ_c^2	108.83* [4.901]	100.48* [4.569]	105.17* [4.893]	111.53* [5.421]	105.54* [5.025]	109.17* [5.027]	105.94* [4.880]	107.72* [5.094]
δ_n^0	3.5640* [4.408]	3.1222* [5.387]	2.9858* [6.116]	3.0718* [5.180]	4.6755* [2.872]	2.7021 [1.569]	2.7647* [3.879]	2.9742* [5.926]
δ_n^1	2.5462 [1.474]	1.2583 [1.155]	.0189 [.083]	.4445 [1.175]	7.4728 [1.126]	-.1881 [-.094]	.1873 [.387]	4.1309 [.992]
δ_c^0	-1.1591 [-.854]	.3027 [.358]	.9582 [1.416]	1.003** [1.733]	2.1602 [.9622]	2.0861 [.715]	.4373 [.554]	.8471 [1.344]
δ_c^1	-5.22** [-1.66]	2.030 [.733]	-.6538 [-.965]	-.0001 [-.000]	5.6019 [.642]	1.5888 [.454]	.3512 [.647]	6.0163 [.577]
Lik.	-153.49	-155.29	-157.34	-155.77	-157.05	-156.01	-157.61	-155.55
MSE	63.1167	69.1112	65.76	60.1706	65.4559	63.0830	65.2778	64.1478
TP	.202251	.205452	.210625	.228171	.20723	.199479	.209832	.20181

Table 11: Z_t = Lagged French Variables and External Variable (2 lags)

	DEBT	ΔINF	ΔIP	ΔRER	TB	M2/R	ΔUR	ΔGDP	ΔDM$
μ_n	1.2559 [1.268]	1.1566 [1.228]	1.2637 [1.254]	1.0802 [1.172]	1.1957 [1.229]	1.2342 [1.208]	1.2506 [1.215]	1.2657 [1.261]	1.2255 [1.24]
μ_c	22.67* [6.873]	20.12* [7.212]	23.19* [7.165]	20.19* [7.393]	21.52* [6.445]	22.50* [6.380]	22.75* [6.724]	23.29* [7.439]	21.92* [7.41]
ρ_n	.9513* [18.40]	.9521* [19.38]	.9516* [17.59]	.9510* [21.24]	.9542* [18.66]	.9505* [18.21]	.9508* [18.40]	.9513* [18.43]	.9439* [15.8]
σ_n^2	3.958* [10.12]	3.502* [9.755]	4.049* [11.16]	3.419* [11.05]	3.758* [9.787]	3.952* [9.989]	3.994* [10.19]	4.064* [10.57]	3.717* [11.4]
σ_c^2	108.6* [5.053]	119.7* [5.831]	104.9* [4.835]	119.7* [5.736]	116.0* [5.453]	109.6* [4.936]	108.2* [4.804]	103.9* [5.084]	109.0* [5.31]
δ_n^0	2.13** [1.764]	4.248* [3.734]	3.484* [4.964]	4.989* [3.305]	4.906* [3.445]	3.60** [1.800]	3.056* [3.537]	3.554* [5.088]	3.343* [4.59]
δ_n^1	5.1041 [.656]	4.885* [2.085]	-.737** [-1.85]	-.512** [-1.83]	15.3** [1.751]	-.8183 [-.343]	-.1722 [-.158]	-14.52* [-2.01]	-.358 [-1.47]
δ_c^0	6.88** [1.713]	1.44** [1.836]	.8048 [1.273]	2.343* [2.168]	-.4754 [-.285]	.8399 [.471]	-.0632 [-.049]	.7687 [1.218]	.6851 [1.04]
δ_c^1	-51.53 [-1.46]	-6.087 [-1.62]	.1813 [.435]	-.3671 [-1.45]	-11.046 [-.858]	-.0347 [-.016]	1.1844 [.772]	2.3858 [.312]	.514** [1.88]
Lik.	-150.69	-148.81	-151.35	-150.75	-151.27	-153.18	-152.94	-151.24	-150.0
MSE	64.649	54.266	68.249	58.483	58.271	64.100	65.347	68.530	61.201
TP	.20377	.17033	.20395	.17912	.18616	.19945	.20357	.20372	.18356

Table 12: Z_t=Lagged Differences Between French and German Variables (2 lags)

	DEBTD	ΔINFD	IPD	ΔRERD	TBD	M2/RD	ΔURD	ΔGDPD
μ_n	1.2618 [1.223]	1.1273 [1.234]	1.1968 [1.199]	1.2224 [1.179]	1.2556 [1.230]	1.2151 [1.225]	1.2416 [1.283]	1.2033 [1.245]
μ_c	22.78* [6.731]	20.10* [7.382]	22.01* [6.107]	22.79* [6.575]	22.98* [7.397]	22.02* [6.505]	22.63* [5.342]	22.22* [6.039]
ρ_n	.9515* [19.29]	.9518* [20.14]	.9514* [17.55]	.9549* [17.81]	.9545* [18.50]	.9491* [18.30]	.9508* [18.19]	.9519* [18.55]
σ_n^2	3.9772* [9.908]	3.3998* [10.76]	3.8419* [10.46]	4.0257* [11.05]	4.0652* [10.66]	3.8446* [9.687]	3.9773* [10.48]	3.8849* [9.727]
σ_c^2	107.95* [4.777]	118.30* [5.893]	112.65* [4.909]	109.27* [4.797]	107.65* [5.157]	111.75* [5.126]	108.94* [5.014]	111.66* [5.145]
δ_n^0	3.1885* [4.426]	4.1632* [4.349]	3.1417* [5.427]	3.3429* [5.079]	6.4462* [3.262]	2.7853 [1.526]	2.9929* [18.293]	3.2257* [5.474]
δ_n^1	1.1680 [.699]	4.1615* [2.528]	-.3365 [-1.295]	-.829** [-1.688]	14.247* [2.034]	-.1793 [-.084]	-.0359 [-.149]	-8.1157 [-1.544]
δ_c^0	-4.0053 [-1.082]	1.2572* [2.004]	.9246 [1.465]	.7626 [1.239]	4.3692 [1.511]	2.2918 [.905]	.3869 [.4482]	.9178 [1.432]
δ_c^1	-10.54* [-1.487]	-1.6107 [-1.142]	.2373 [.586]	.0563 [.165]	14.977 [1.332]	1.7908 [.603]	.3718 [.635]	4.6945 [.6263]
Lik.	-150.46	-149.49	-152.26	-151.86	-150.21	-153.05	-153.04	-151.92
MSE	64.9784	55.6026	62.1963	65.9808	65.1653	62.4989	64.9009	63.3464
TP	.204081	.163023	.194461	.205387	.197875	.196703	.202541	.195979

Figure 14a: p_{cc} $\Delta INFD_t$

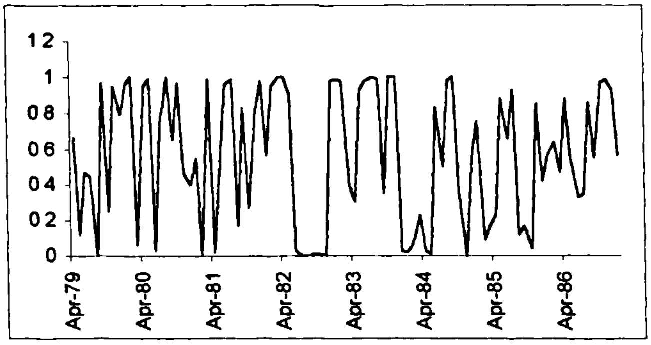


Figure 14b: p_{cc} ΔINF_{t-1}

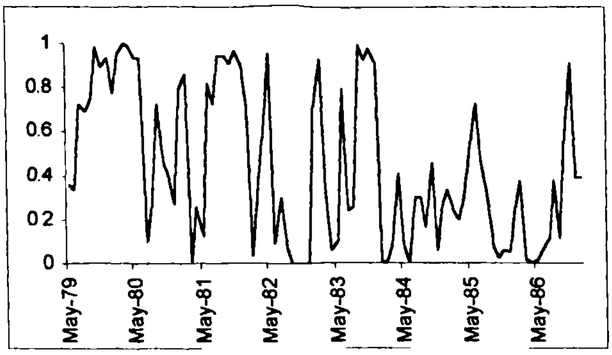


Figure 14c: p_{nn} ΔGDP_t

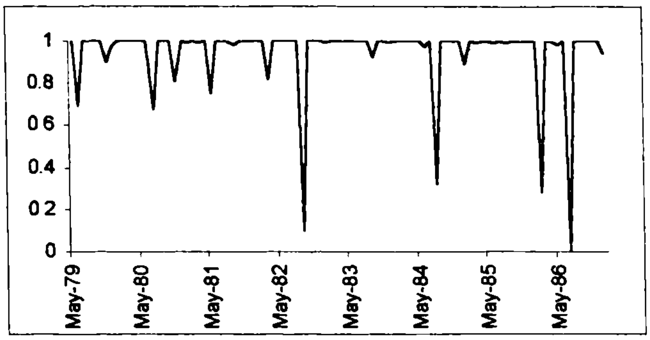


Figure 14d: p_{nn} ΔRER_{t-2}

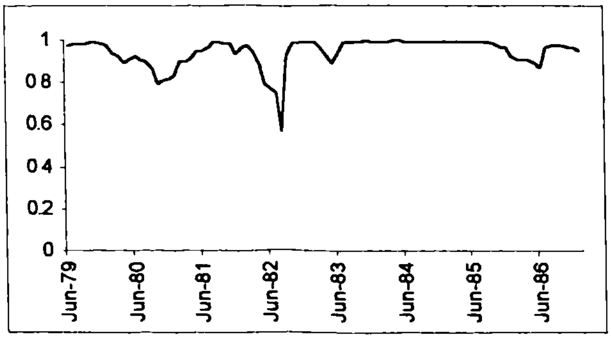


Figure 14e: p_{nn} ΔTB_{t-2}

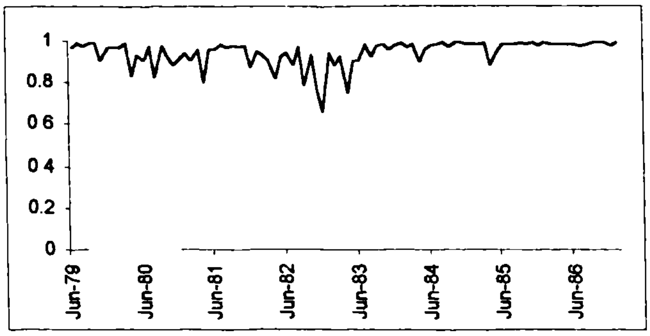


Figure 14f: p_{nn} $\Delta RERD_{t-2}$

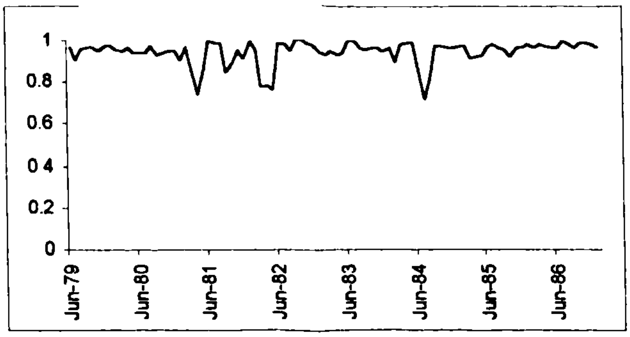
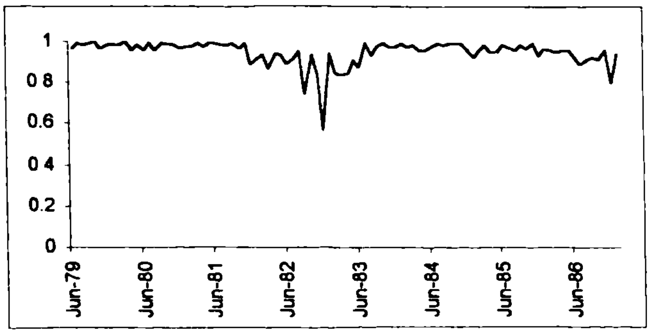


Figure 14g: p_{nn} ΔTBD_{t-2}



B. Sample 1987M02 – 1993M07

Tables 13 to 18 summarise the findings on the effect of the various indicators on realignment expectations regarding the franc. Numbers in square brackets below the parameter estimates are t-statistics. In all tables, the mean in the crisis regime, μ_c, the three autoregressive parameters (ρ_1, ρ_2, ρ_3)[3], and the variance in each regime (σ_n^2 and σ_c^2) are all statistically significant and of the same magnitude as in Table 6c (FTP model). Additionally, the fixed parameter for the transition probabilities from the normal state, δ_n^0, is statistically significant[4] and positive, confirming that when realignment expectations are low and stable, they tend to remain so. In like manner, the fixed parameter for the transition probabilities from the crisis regime, δ_c^0, is also often -though not always- statistically different from zero and positive, meaning that when realignment expectations are high and unstable, they tend to remain so.

Table 13 contains the inference on the current French economic factors and German mark depreciation rate against the dollar. Three variables are statistically significant and theoretically consistent. These include the change in the inflation rate, ΔINF; and the change in the unemployment rate, ΔUR, in the crisis regime as well as the German mark depreciation rate against the dollar, ΔDM$, in the normal regime. For example, if ΔINF exceeds -0.798 percent, the realignment expectation is more likely to remain in the crisis regime than to switch to the normal state. Likewise, if ΔUR exceeds -0.1847 percentage point, the probability of remaining in the crisis state, p_{cc}, is above the 0.5 critical value. Figures 15a and 15b plot p_{cc} with ΔINF and ΔUR as forcing variables, respectively. Because ΔINF exceeds its trigger value most of the time (see Figure F2 in Appendix 4.1), Figure 15a shows that p_{cc} is close to unity during the entire sample period (to the exception of one slump in April 1988). Figure 15b, by contrast, shows that p_{cc} is equal to one during two periods: 87M05-88M1 and 91M03-93M07 and to zero in between these periods. In fact, Figure 15a is relatively similar to Figure 14 which revealed that realignment expectations are in the crisis regime in 87M11 and 92M09-93M07.

[3] Note that ρ_3 is not statistically significant in the case of IPD in Table 17; and for ΔINF and ΔRER in Table 18.

In turn, a German mark depreciation tends to increase the likelihood that realignment expectations stay low and stable. p_{nn} is greater than 0.5 as long as ΔDM$ exceeds -6.835 percent,. In fact, this is the case throughout the entire sample period (see Figure F9 in Appendix 4.1.). Hence, the plot of p_{nn} for ΔDM$ in Figure 15c is constantly close to one (to the exception of January 1988). Otherwise, the parameter on ΔDM$ is also statistically different from zero in the crisis state but its sign is contrary to theoretical predictions. Although some other indicators have the correct signs (DEBT in both states; ΔIP, ΔRER, TB and ΔGDP in the normal regime; and M2/R in the crisis state), their coefficients are not statistically significant. Finally, other parameters are not signed as theoretically anticipated and their parameters are not statistically different from zero (ΔINF, TB and M2/R in the normal regime as well as ΔIP, ΔRER, TB and ΔGDP in the crisis state).

Table 14 presents the results for current differentials between the French and German variables. None of the indicators is both statistically significant and correctly signed. The coefficient for IPD is statistically different from zero in the crisis state but does not have the anticipated sign. DEBTD and ΔURD, conversely, display the correct signs in both regimes but are statistically insignificant. Also, IPD and ΔGDPD in the normal regime, ΔINFD and ΔRERD in the crisis state, have the anticipated signs but the parameters are not statistically different from zero. Finally, the other indicators are statistically insignificant and theoretically inconsistent (ΔINFD, ΔRERD, TBD, M2/RD in the normal regime, and TBD, M2/RD and ΔGDPD in the crisis state).

Table 15 summarises the findings on the one-month-lagged French variables and German mark depreciation rate against the dollar. Three indicators are correctly signed and statistically significant: DEBT and ΔUR in the crisis state and ΔDM$ in the normal state. Figures 15d and 15e plot the conditional probabilities of remaining in the crisis state, p_{cc}, for one-month-lagged DEBT and ΔUR, respectively. In Figure 15d, p_{cc} is close to one in most of the sample period although it falls below 0.5 on two occasions: 87M10&11 and 88M03&04. This means that, when devaluation expectations are high, a higher debt to GDP ratio contributes significantly to

[4] Exceptions include the cases of debt and the M2 to reserves ratio in Tables 16, 17, 18, 19, and 20; the trade balance in Table 18, and ΔDM$ in Table 24.

their remaining high. More precisely, because DEBT exceeds its trigger value of 0.24 from 1988 on (see Figure F1 in Appendix 4.1), p_{cc} remains above 0.5. The conclusions to derive from Figure 15e (the plot of p_{cc} for one-month-lagged ΔUR) are the same as for Figure 15b (p_{cc} for current ΔUR) since the two plots are the same. Therefore, this confirms that unemployment played a substantial role in forcing speculative attacks against the French franc (the trigger value of one-month-lagged ΔUR is -0.1191 percent). Once again, a dollar appreciation against the German mark prolongs the probability that the expected realignment rate will remain stable and low, p_{nn}. Figure 15f corroborates the conclusions of Figure 15c as the two plots are closely related (the trigger value of ΔDM$ is -7.355 percent). The parameters for p_{nn} are statistically significant for ΔINF and TB but do not have the expected sign. Other indicators have the correct signs but are statistically insignificant (in the normal regime, ΔRER and ΔUR, in the crisis state ΔINF, ΔIP, TB, M2R and ΔGDP). Finally, the remaining indicators are statistically insignificant and theoretically inconsistent: DEBT, ΔIP, TB, M2/R and ΔGDP in the normal regime, and ΔRER and ΔDM$ in the crisis state.

Table 16 presents the results on the explanatory power of the one-month-lagged French-German differentials. One of the proposed indicators is statistically significant and displays the correct sign: ΔINFD in the normal regime. That is, as long as the inflation rate differential is below 0.797 percent, the realignment expectation is more likely to stay in the normal state than to shift to the crisis regime. Figure 15g plots p_{nn} with ΔINFD as forcing variable. Once again p_{nn} is very high since ΔINFD is below its trigger value throughout the sample period (Figure F2, Appendix 4.1.). The only significant exception is February 1993, when p_{nn} drops to about 0.1. This observation falls within one of the crisis episodes previously identified but cannot alone explain the switch to high devaluation expectations in the 1992/93 period. M2/RD is also statistically significant in the crisis state but its coefficient is not correctly signed. Although ΔURD displays the expected signs in the two regimes, the parameters are not statistically different from zero. Likewise the other correctly signed indicators (DEBTD and ΔGDPD in the crisis state) are not statistically significant. Lastly, the rest of the one-month-lagged indicators are statistically insignificant and theoretically inconsistent (DEBTD, IPD, ΔRERD, TBD, M2/RD and ΔGDPD in the normal regime, as well as ΔINFD, IPD, ΔRERD, and TBD in the crisis state).

Table 17 shows the estimation results for the two-month-lagged French economic variables and German mark depreciation rate against the dollar. Three indicators prove statistically significant and display the correct signs. First, if ΔUR is lower than 1.709 percent, p_{nn} exceeds 0.5. Figure 15i plots p_{nn} for two-month-lagged ΔUR. The series takes values close to unity throughout the whole period. Yet, this does not contradict the conclusions derived from Figures 15b and 15e (which clearly suggested that rises in unemployment provoked the crises) since explanatory variables need not have a symmetrical effects on the two states. Secondly, when ΔIP exceeds the value of 0.838 percent, p_{cc} falls below 0.5. Finally, slow real GDP growth contributes to high values of p_{cc} (conversely, if ΔGDP exceeds 0.0333 percent, the probability that the realignment expectation will shift from the crisis to the normal state is greater than 0.5). Figures 15h and 15j plot p_{cc} for two-month-lagged ΔIP and ΔGDP, respectively. Naturally, the two plots are very closely related since both variables aim to measure the role of real output growth. The two graphs show that p_{cc} is very volatile until mid-1991 before stabilising at very high levels until the end of the period with the exception of 93M06. It therefore seems that slow growth did indeed contribute significantly to the franc crisis of the early 1990s. The parameter on TB is also statistically significant in the normal regime, however its sign is not as theoretically anticipated. On the other hand, the coefficients for ΔIP, ΔRER, ΔGDP and ΔDM$ in the normal state; as well as DEBT, ΔINF, and M2/R in the crisis regime are all correctly signed but are not statistically different from zero. Finally, the remaining variables are both statistically insignificant and theoretically inconsistent (DEBT, ΔINF, and M2/R in the normal regime, ΔRER, TB, ΔUR as well as ΔDM$ in the crisis state).

Table 18 summarises the findings regarding the two-month-lagged differentials between the French and German indicators. Four indicators are theoretically consistent and statistically significant: DEBTD and ΔURD in the normal regime, as well as IPD and ΔGDPD in the crisis regime. When DEBTD is lower than 0.54 and ΔURD is below 4.067 percent, the probability of staying in the normal regime exceeds 0.5. Vice versa, when ΔGDPD is less than 0.0579 percent and IPD is below 2.875 percent, p_{cc} exceeds 0.5. Figures 15k and 15m plot p_{nn} for two-month-lagged DEBTD and ΔURD, respectively. Clearly, p_{nn} is very stable and high over the whole sample period, confirming that the forcing variables never reach their respective trigger values (see Figures F10 and F16 in Appendix 4.1.). p_{cc} for IPD and ΔGDPD in Figures 15*l* and 15n, respectively, are much more volatile because the trigger values are passed on many occasions (see Figure F12 and F17 in Appendix 4.1.). In accordance with previous results, p_{cc} exhibit large fluctuations in the first half of the sample and stabilises to high values thereafter[5]. ΔRERD and M2/RD are also statistically significant in the normal regime but they do not have the expected signs. Conversely, some indicators are correctly signed but their coefficients are not statistically different from zero (ΔINF in both states; ΔGDPD in the normal regime; ΔRERD and ΔURD in the crisis regime). The rest of the two-month-lagged differentials are neither statistically significant nor theoretically consistent. These include TBD in both regimes, IPD in the normal state, as well as DEBTD and M2/RD in the crisis state.

[5] Note however that volatility is less important for ΔIPD than for ΔGDPD and that the conditional transition probability drops to a very low value in June and July 1993 for ΔGDPD.

Table 13: Z_t = Current French Variables and External Variable

	DEBT	ΔINF	ΔIP	ΔRER	TB	M2/R	ΔUR	ΔGDP	ΔDM$
μ_n	.4596 [.367]	.2217 [.238]	.2803 [.272]	- 0658 [-.065]	.4491 [316]	.2339 [.241]	.4593 [416]	.26466 [266]	.3434 [254]
μ_c	4.2642* [2.156]	5.3506* [2 772]	5.3436* [2 386]	4.8046* [2.599]	10.881* [3.096]	5.1922* [2 067]	4.3848* [2.653]	5.4242* [2 558]	3.558** [1.713]
ρ_1	1.3540* [11.74]	1 3864* [13 03]	1.3881* [13.34]	1.2048* [14.64]	1.3256* [12 33]	1.3729* [11.03]	1 3656* [14.44]	1.3867* [13.21]	1.3401* [12 34]
ρ_2	-.7095* [-4 580]	-.7859* [-4 788]	-.7689* [-4.809]	-.5429* [-4.347]	-.7030* [-4 759]	-.7651* [-4.204]	-.7078* [-5.606]	-.7675* [-4.730]	-.6984* [-4.646]
ρ_3	.2498* [2.612]	.2600* [2.508]	.24908* [2 197]	.2083* [2.533]	.2863* [3.719]	.2555* [2 429]	2253* [2.290]	.24711* [2.187]	.2576* [2.733]
σ_n^2	.9277* [10.53]	.8187* [10.41]	8454* [9.19]	.9293* [10 01]	.8913* [10 25]	.8209* [9.586]	8669* [9.028]	.84044* [9.513]	.9369* [10 85]
σ_c^2	11.967* [4.680]	10.789* [5.095]	10.658* [4.507]	10.185* [4.821]	9.619* [5.613]	10.286* [5.002]	11.81* [4.763]	10.583* [4.552]	15.865* [4 837]
δ_n^0	7.8689 [.401]	4.8421* [5.228]	4.4799* [5.652]	3.6735* [4.603]	2.4464* [2.086]	-.6360 [-.082]	4.5073* [4.561]	4.4800* [5.598]	10.618* [2.379]
δ_n^1	-12.404 [-.170]	2.4558 [627]	.3626 [493]	-.2879 [-.911]	-131** [-1.641]	5.5855 [651]	-.9959 [-.786]	9.8651 [527]	1.5529* [2.019]
δ_c^0	-24.236 [-1.253]	4.8008* [3.185]	3.3531* [3.227]	41.95 [.016]	12.6296 [1 443]	-22.36 [-1.367]	2.6362* [2.344]	3.3688* [3.173]	8.255** [1.786]
δ_c^1	103.33 [1 356]	6 0089* [2.118]	.3821 [.343]	-99.64 [-.028]	122.79 [1.383]	28.08 [1 531]	14.27** [1.810]	11 7633 [.457]	1.336** [1 654]
Lik.	-60 87	-60.38	-62 37	-60.32	-58 06	-60 99	-59 41	-62.33	-58 52
MSE	11 2166	11 2121	11.2668	11 9636	11 2041	11.2681	10 9061	11 2706	11.1997
TP	.149688	.15301	.147048	158249	18031	.167028	159477	146563	15645

Table 14: Z_t=Current Differences in the French and German Variables

	DEBTD	ΔINFD	IPD	ΔRERD	TBD	M2/RD	ΔURD	ΔGDPD
μ_n	.4428 [.355]	.284 6 [.291]	.3931 [439]	.5905 [.496]	.3542 [.309]	.4637 [.378]	.4477 [.375]	.3134 [.207]
μ_c	4.2194* [2.107]	5.2260* [2.644]	5.5971* [4.759]	3.561** [1.976]	4.6047* [2.006]	4.3361* [2.216]	4.3029* [2.235]	4.6861* [2.020]
ρ_1	1.3516* [11.51]	1.3854* [13 38]	1.3149* [12 25]	1.3549* [12.20]	1.3574* [8.207]	1.3686* [12.55]	1.3562* [11.69]	1.3948* [12.78]
ρ_2	-.7059* [-4 464]	-.7749* [-4.914]	-.5677* [-3 782]	-.7084* [-4.824]	-.7398* [-3.603]	-.7309* [-4.795]	-.7143* [-4.466]	-.7704* [-4.746]
ρ_3	.2482* [2.579]	.2552* [2.434]	.1151 [1.371]	.2488* [3.105]	.2644* [2.448]	.2541* [2.566]	.2478* [2.441]	.2528* [2 332]
σ_n^2	.9266* [10.51]	.8317* [9 863]	.8321* [9.840]	.9036* [11.34]	.9009* [8.004]	.9092* [10 31]	.9100* [10.09]	.8860* [8 932]
σ_c^2	11.91* [4.716]	10.509* [4.955]	3.3052* [3.229]	20.262* [4.132]	11.030* [4.709]	11.915* 4 736]	11.700* [4.759]	11.969* [4.320]
δ_n^0	5.5932* [2.037]	4.8838* [4.738]	3.6050* [6.568]	135.87* [.652]	3.8182* [2.277]	5.0659 [1.079]	5.5572* [2.284]	4.5123* [5.373]
δ_n^1	-4.2189 [- 442]	1.8419 [.689]	.0866 [.299]	77.01 [.649]	-3.3943 [- 395]	.4442 [.114]	-.4704 [-.553]	.6289 [011]
δ_c^0	-1.799 [-.581]	3.8103* [3.245]	2.9526* [2.221]	19.36 [.057]	7.641** [1.720]	-5.0286 [-.985]	-3.9364 [-.704]	3.3361* [3.448]
δ_c^1	22.46 [1 269]	1.8716 [.863]	2.3698* [2 142]	26.54 [.058]	18.415 [1.093]	-8.0967 [-1 500]	3.3166 [1.198]	1.1109 [041]
Lik.	-60.64	-62.09	-60.50	-51.39	-61.074	-61 167	-60.625	-62.510
MSE	11.209	11.1677	12 0981	11.3173	11.2919	11 1732	11 1706	11.2289
TP	15017	.155863	.097683	.154236	.158662	.153905	.153216	.148273

Table 15: Z_t=Lagged French Variables and External Variable (1 lag)

	DEBT	ΔINF	ΔIP	ΔRER	TB	M2/R	ΔUR	ΔGDP	ΔDM$
μ_n	.3628 [.361]	.3124 [.368]	.1579 [.171]	.3531 [.354]	.2198 [.175]	.01846 [.022]	.4013 [.348]	.1611 [.170]	.3013 [.317]
μ_c	4.3596* [2 854]	3.091** [1 879]	5.7261* [3.614]	5.2443* [3.547]	1.5448 [1.032]	6.4552* [4 617]	4.2951* [2.491]	5.6854* [3.401]	4.5019* [2 693]
ρ_1	1.3627* [15 08]	1.2666* [12.96]	1.3637* [13 65]	1.3911* [15.47]	1.1946* [11.05]	1.3247* [13.91]	1.3622* [13 94]	1.3628* [13.41]	1.3713* [14 19]
ρ_2	-.6912* [-5.992]	-.5661* [-4.061]	-.7226* [-4.387]	-.6902* [-5.278]	-.5135* [-3.606]	-.7019* [-5.016]	-.7018* [-5.319]	-.7266* [-4.406]	-.7244* [-4.732]
ρ_3	.1999* [2.308]	.1447 [1.562]	.2196* [1.952]	.1688 [1.597]	.1982* [2.151]	.2709* [3.290]	.2251* [2.273]	.2247* [2.033]	.2189* [2.072]
σ_n^2	.8248* [9.760]	.8717* [10.39]	.8308* [10.33]	.8495* [9.447]	.97365* [10 31]	.9959* [10.91]	.8887* [9.143]	.8317* [10.29]	.8383* [10.33]
σ_c^2	11.357* [4.758]	10.162* [5.009]	9.7158* [4.488]	10.21* [3.926]	13.389* [4.142]	7.5604* [3.741]	11.764* [4.809]	9.7296* [4.724]	10.899* [4.936]
δ_n^0	-8.0228 [-.608]	5.7372* [4.009]	4.3779* [5 448]	3.4309* [4.418]	1.5452 [1.053]	-1.1551 [-.177]	4.5456* [4.424]	4.5259* [4.753]	6.4997* [3.221]
δ_n^1	46.628 [.915]	7.8953* [2.425]	-.0402 [-.058]	-.3374 [-1.132]	-135** [-1.729]	5.7941 [803]	-1.1732 [-.881]	-7.2752 [-.346]	.8835** [1.846]
δ_c^0	-31.6** [-1 848]	3.7492* [2.496]	4.0396* [2.785]	1.7267 [1.533]	.2307 [.255]	-70.23 [-1.502]	2.3232* [2.071]	4.1256* [2.818]	3.3909* [2 642]
δ_c^1	131.77* [1.937]	5.2639 [1.375]	-2.1237 [-1.566]	-.9443 [-1.632]	-57.12 [-1 478]	76.73 [1.562]	19.46* [1.786]	-47.29 [-1.557]	.2658 [.740]
Lik	-59.980	-60.586	-61.122	-61.018	-56 856	-59 61	-59.59	-61.14	-60.66
MSE	11 0810	11.4039	11.3264	11.3019	11.4779	11.7075	11.1446	11.3174	11.3079
TP	.16254	.163098	152527	.122542	.133754	.124846	.167781	.160849	15749

Table 16: Z_t=Lagged Differences Between French and German Variables (1 lag)

	DEBTD	ΔINFD	IPD	ΔRERD	TBD	M2/RD	ΔURD	ΔGDPD
μ_n	.3702 [.339]	.2522 [.187]	.3311 [.266]	.3466 [.339]	.3206 [288]	.4036 [.406]	.3847 [.324]	.1729 [.186]
μ_c	4.2403* [2.502]	5.4557* [3 508]	3.7470 [1.471]	4.1319* [2.314]	4.6294* [2.215]	4.3858* [3 109]	4.3006* [2.248]	5.8008* [3.977]
ρ_1	1.3539* [13.28]	1.4094* [12.41]	1.3221* [9.386]	1.3738* [13.23]	1.3804* [12.68]	1.3429* [16 14]	1.3597* [12.04]	1.3562* [13.93]
ρ_2	-.6902* [-5.225]	-.7191* [-4.147]	-.6894* [-3.771]	-.7382* [-4 581]	-.7497* [-4.233]	-.6422* [5.786]	-.7123* [-4.376]	-.7074* [-4.402]
ρ_3	.2160* [2.005]	.2101** [1.942]	.2552* [2.483]	.2360* [2.189]	.2476* [2.267]	.1689* [2.016]	.2391* [2.259]	.2119** [1.914]
σ_n^2	.8724* [7 978]	.9125* [9.625]	.9558* [10.05]	.8569* [9.504]	.8803* [9 071]	.8127* [9 631]	.9052* [9.729]	.8303* [10.18]
σ_c^2	11.547* [4.727]	2.2821* [2.668]	11.215* [4.676]	12.334* [4.758]	11.218* [4.825]	8.8459* [3.822]	11.587* [4.775]	9.2191* [4.442]
δ_n^0	4.0902 [1.373]	4.2421* [4.949]	5.3484* [3.743]	5.8382* [3.363]	3.7607* [2.307]	4.0685 [1.625]	5.6158* [2.163]	4.8535* [3 685]
δ_n^1	.8149 [072]	-5.319* [-3.004]	-.9206 [-1.254]	2.3682 [1.458]	-3.5027 [-.432]	.3618 [.176]	-5148 [-.577]	-21.08 [-1.160]
δ_c^0	-2.4853 [-.869]	.9403 [1.354]	4.1783* [2.373]	3.0325* [2.479]	6.8029* [1.971]	-15.5** [-1.930]	-4.424* [-.762]	3.6519* [3 195]
δ_c^1	24.833 [1 625]	-.4398 [-.298]	1.3367 [.988]	-.9665 [-.547]	14.744 [1.286]	-17.32* [-2 063]	3.6178 [1.276]	-24.08 [-1.349]
Lik	-60.36	-57 84	-61.28	-61.34	-61 07	-59.80	-60.22	-60.87
MSE	11.1932	11.5331	11.2946	11.2733	11.2919	11.2667	11 2427	11 3503
TP	.155388	097137	.15384	.146341	.153741	132715	.156646	157176

Table 17: Z_t=**Lagged French Variables and External Variable (2 lags)**

	DEBT	ΔINF	ΔIP	ΔRER	TB	M2/R	ΔUR	ΔGDP	ΔDM$
μ_n	.3661 [.350]	.4339 [.334]	.3954 [.282]	.3819 [.324]	.6336 [.523]	.3488 [.269]	.6489 [.536]	.3917 [.284]	.2349 [.250]
μ_c	4.2152* [2.421]	4.146** [1.913]	5.2902* [2.815]	4.499** [1.895]	4.5355* [3.024]	4.107** [1 872]	4.2762* [2.934]	5.2981* [2.867]	4.8503* [2.558]
ρ_1	1.3502* [12.06]	1.3689* [11.99]	1.4131* [14 21]	1.3696* [11.22]	1.3438* [16.51]	1.3426* [10 36]	1.3428* [13.82]	1.4140* [14 36]	1.4157* [13.09]
ρ_2	-.6888* [-4.861]	-.7372* [-4.695]	-.7202* [-4 919]	-.7251* [-4 524]	-.6645* [-5 555]	-.7068* [-4 081]	-.6726* [-4 584]	-.7219* [-4.999]	-.8240* [-4.908]
ρ_3	.2108* [2.054]	.2623* [2.679]	.2077* [2.181]	.2393* [2.079]	.2127* [2.452]	.2560* [2.472]	.2151* [2.094]	.2086* [2.209]	.2671* [2 525]
σ_n^2	.8685* [8.942]	.9503* [10.36]	.9386* [10.73]	.9213* [9.319]	.9340* [10.97]	.9608* [10.07]	.9148* [9.779]	.9374* [10.72]	.8149* [10.06]
σ_c^2	11.203* [4.752]	12.114* [4.796]	10.596* [3.709]	11.402* [4.562]	13.001* [3.128]	11.511* [4 737]	11.558* [2.320]	10.558* [3.702]	11.248* [5 705]
δ_n^0	-8.248 [-.532]	4.7629* [4.332]	4.1392* [6.043]	3.9996* [3.238]	1.9809* [2.713]	-9.5187 [-.881]	4.3251* [3.695]	4.1410* [6.046]	7.0765 [1.407]
δ_n^1	47.531 [.799]	1.6655 [412]	.4119 [.662]	-.1956 [-.514]	-81.1** [-1 889]	15.735 [1.231]	-2.53** [-1.899]	10.6636 [675]	.8003 [.665]
δ_c^0	-26.471 [-1.491]	4.9873 [1.290]	4.2508* [2 473]	2.4788* [2.036]	3 2530 [1.178]	-13.861 [-1.058]	1.2764 [.711]	4.3075* [2 476]	60.242 [.0317]
δ_c^1	111 6 [1.615]	9.2193 [721]	-5.07** [1.968]	-.7539 [-1 231]	47.876 [1.111]	19.011 [1.258]	-.8120 [-.501]	-129** [-1 829]	8.8737 [.032]
Lik.	-60 62	-61.62	-58.48	-61.36	-54 40	-60.41	-59.93	-58.30	-59.08
Mse	11.3459	11.3708	11.4099	11.3729	11.5357	11.4170	11.4387	11.3995	11.36
TP	.16605	.173909	.115552	.153393	.119935	.157537	102948	117504	.15964

Table 18: Z_t=**Lagged Differences Between French and German Variables (2 lags)**

	DEBTD	ΔINFD	IPD	ΔRERD	TBD	M2/RD	ΔURD	ΔGDPD
μ_n	.4524 [.343]	.1137 [.111]	.4731 [.340]	.3842 [.442]	.4978 [387]	.1501 [.156]	.5301 [.388]	.4603 [.333]
μ_c	4.2934* [2.426]	5.7902* [3.957]	5.5083* [2.998]	4.1956* [2 688]	4.5276* [2.308]	4.9239* [2.579]	4.5812* [2.248]	5.5692* [3.167]
ρ_1	1.3413* [13.87]	1.3425* [8.579]	1.4296* [14.72]	1.3622* [13.23]	1.3710* [12.46]	1.4156* [13.21]	1.3919* [12.32]	1.4267* [15.38]
ρ_2	-.6501* [-4 371]	-.6804* [-4.163]	-.7606* [-5.529]	-.7216* [-4.578]	-.7169* [-4.916]	-.8282* [-4.973]	-.7482* [-5.018]	-.7396* [-5 663]
ρ_3	.2042* [2.015]	.206*** [1.668]	.2327* [2.525]	.2102* [2.116]	.2412* [2.658]	.2747* [2 613]	.2557* [2.912]	.2164* [2.504]
σ_n^2	.9395* [10.32]	.8859* [6.812]	.9506* [10 41]	.8515* [10 16]	9398* [10.51]	.8128* [10.03]	.9278* [10.30]	.9403* [10 82]
σ_c^2	8.5153 [1.528]	8.2419* [3.628]	12.388* [3.078]	11.167* [5.647]	11.863* [4.749]	10.464* [6.009]	10.799* [5.558]	9.5632* [3.608]
δ_n^0	7.6596* [3.241]	4.0103* [6.594]	4.4898* [2.666]	29.49* [18.69]	2.8272* [2.223]	82 18* [7.641]	37.83* [12.99]	4.2779* [6.176]
δ_n^1	-14.16* [-2.204]	-1.7975 [-.573]	-.4841 [-.349]	17.75* [18 69]	-9.466 [-1.038]	51.296* [3.291]	-9.301* [-12.5]	6.0733 [491]
δ_c^0	1.7866 [868]	3.6726* [2 597]	4.1423* [2.083]	34.56** [1.647]	12.238* [2.030]	-93.17 [-.620]	-336 8 [-.096]	4.0512* [2.963]
δ_c^1	-4 8250 [-.739]	4.6181 [1.372]	-1.44** [-1.914]	18.52 [1.619]	37.58 [1.622]	-125 5 [-.627]	217.99 [.096]	-69.9** [-1.939]
Lik.	-60.43	-59 80	-60.55	-56.79	-58.37	-58.15	-56.42	-58.71
Mse	11.5656	11 7628	11.4341	11.5789	11.337	11.3631	11.3501	11.4063
TP	10811	.098562	.124101	.195976	.16196	.190896	.196012	.115723

Figure 15a: p_{cc} ΔINF_t

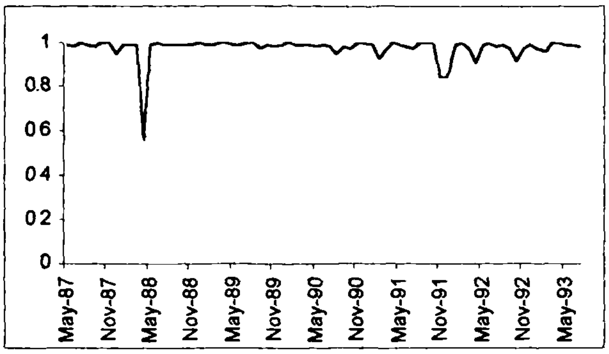


Figure 15b: p_{cc} ΔUR_t

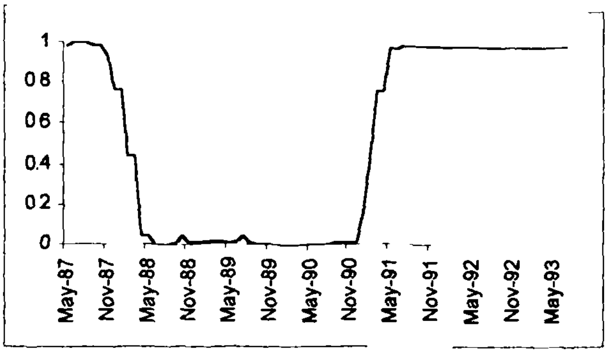


Figure 15c: p_{nn} $\Delta DM\$_t$

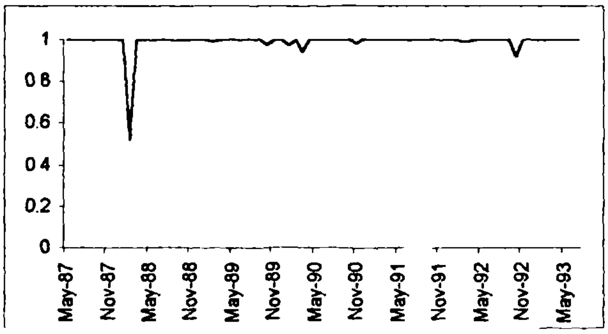


Figure 15d: p_{cc} $DEBT_{t-1}$

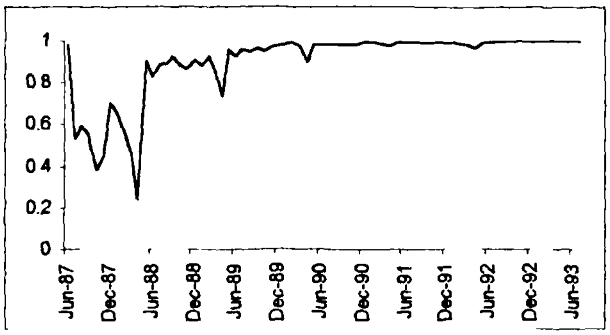


Figure 15e: p_{cc} ΔUR_{t-1}

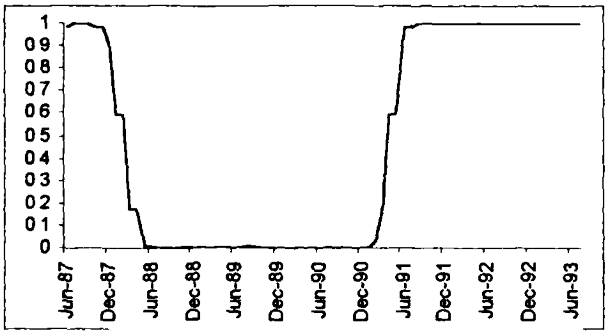


Figure 15f: p_{nn} $\Delta DM\$_{t-1}$

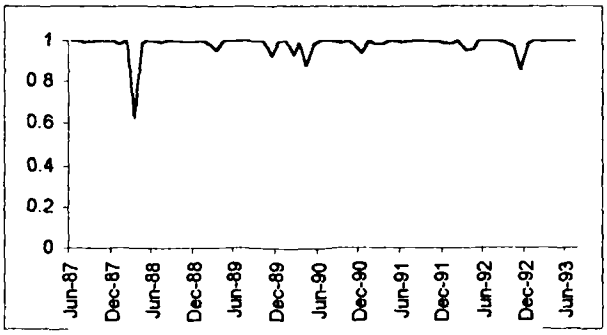


Figure 15g: p_{nn} $\Delta INFD_{t-1}$

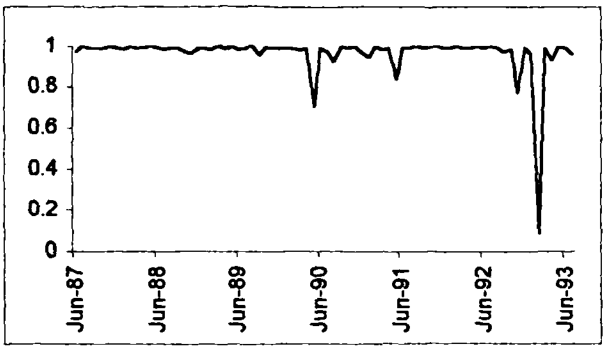


Figure 15h: p_{cc} ΔIP_{t-2}

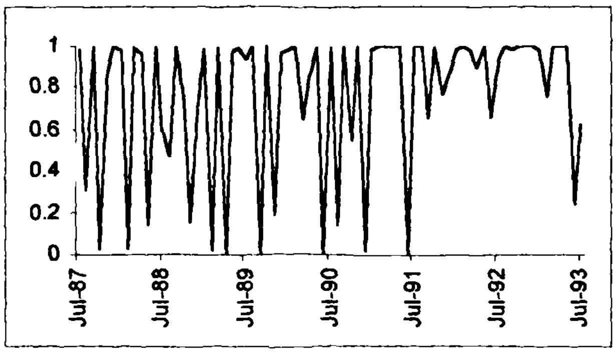


Figure 15i: p_{nn} ΔUR_{t-2}

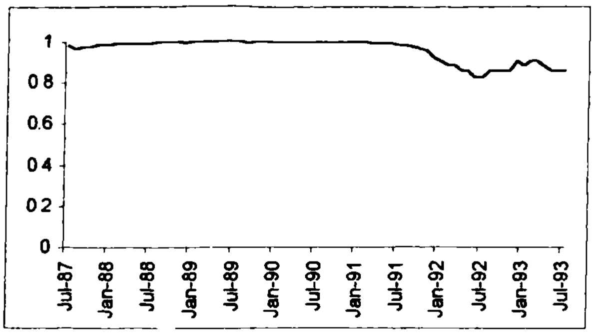


Figure 15j: p_{cc} ΔGDP_{t-2}

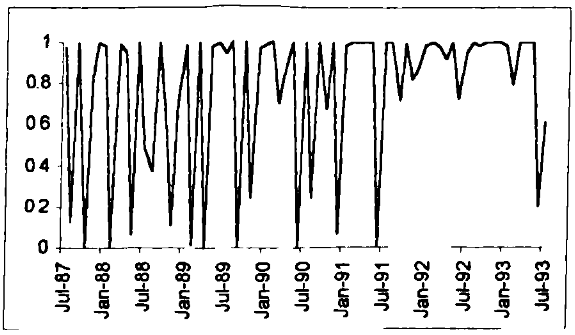


Figure 15k: p_{nn} $DEBTD_{t-2}$

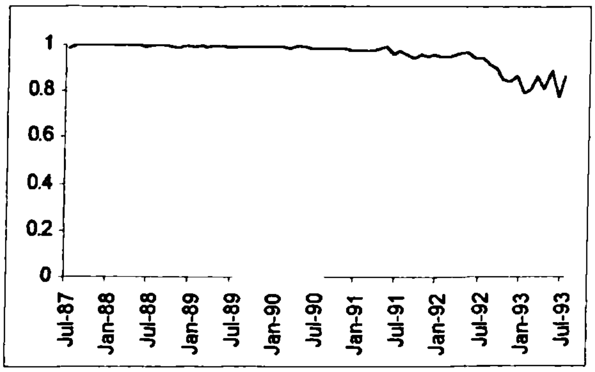


Figure 15l: p_{cc} IPD_{t-2}

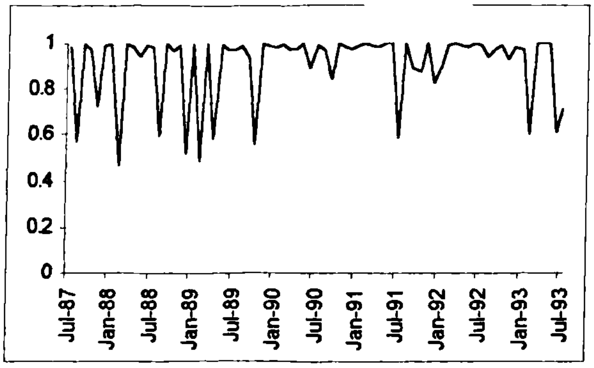


Figure 15m: p_{nn} ΔURD_{t-2}

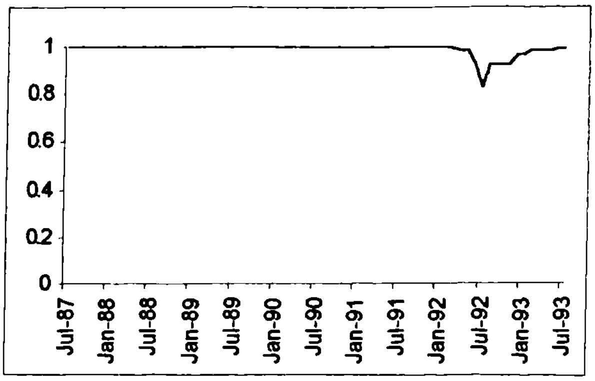
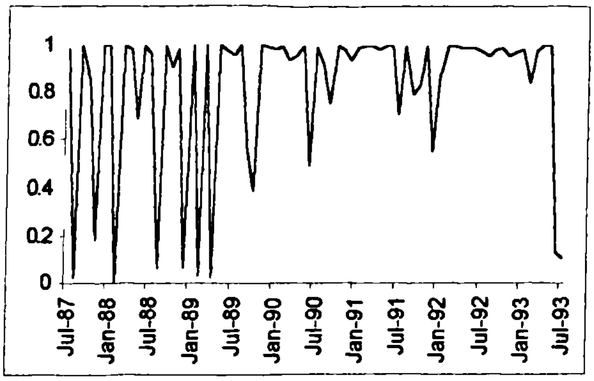


Figure 15n: p_{cc} $\Delta GDPD_{t-2}$



6. 4. 4. Conclusions on the French Realignment Expectations

In the first section of our investigation, the expected realignment rate for the French franc was estimated using the drift-adjustment methodology. As in previous applications of the technique[6], our empirical results indicated that expectations of franc devaluation against the DEM were positive for most of the period from 1979 to 1993, despite occasional signs of expected revaluation in the 1990s.

The application of the regime switching model with fixed transition probabilities (MSM-FTP) identified a structural change in the pattern of the realignment expectation series and the sample period was therefore split in two: March 1979-January 1987 and February 1987-July 1993. The MSM-FTP results for both sub-samples showed that the expected realignment rate can be described as a mixture of two normal distributions corresponding to two states: a state of low and stable expectations (the so-called normal regime) and a state of high and volatile expectations (or crisis regime). The classification of each sub-period between crisis and calm episodes -on the basis of the unconditional probabilities of being in each state- proved successful in the sense that it fitted the actual history of the French franc. As a result, the effects of various indicators on the transitions between the two regimes followed by the estimated expected realignment rate were investigated in a second section.

In the first sub-period, inflation, competitiveness and the trade balance appear to have a consistent impact on regime shifts. More precisely, an increase in current domestic inflation relative to Germany, and in one-month-lagged domestic inflation, is associated with a high probability that the expected realignment rate will remain high and volatile. Conversely, an improvement in two-month-lagged domestic -and domestic relative to German-competitiveness and in two-month-lagged trade balance makes it more likely that the credibility of franc will be high and stable. Similarly, higher one-month-lagged GDP growth is associated with the likelihood that the franc will remain credible. On the other hand, there is no statistically significant links between the shifts of the expected realignment rate and up to three lags of debt, industrial production, M2 to reserves ratio and German mark depreciation rate against the dollar.

More significant findings of linkages between the economic indicators and realignment expectations are found in the second sub-period. In particular, changes in the unemployment rate affect the transition probabilities from both regimes. That is, when the one-month-lagged unemployment rate increases, realignment expectations are more likely to stay high and volatile, whilst when the two-month-lagged domestic and differential unemployment rate decrease, the franc is more likely to remain credible and stable. Similarly, a fall in the output growth rate (as given by changes in domestic and differential GDP and industrial production) appear to determine transitions from the crisis regime two months ahead. A current and one-month-lagged dollar appreciation against the German mark also has a positive influence on the probability that the expected realignment rate will remain low and stable. Furthermore, decreases in the two-month-lagged domestic debt/GDP ratio relative to Germany and in the one-month-lagged inflation differential raise the likelihood that the franc will be credible. Finally, increases in the one-month-lagged domestic debt GDP ratio and in the current inflation rate will prolong the crisis regime.

A related study to the investigation of the 1987-1993 period is Jeanne & Masson (1998) who also measure drift-adjusted realignment expectations for the franc over that period and employ a regime switching technique. It is therefore of interest that Jeanne & Masson also find that unemployment plays an important role and that the real exchange rate does not. Contrary to our findings, however, the trade balance is a consistent and statistically significant in their analysis. It should be noted nonetheless that Jeanne & Masson use a Markov regime switching model with fixed transition probabilities, so that economic fundamentals influence the level of realignment expectations and not the transition probabilities[7]. Therefore, it may well be that the divergent conclusions regarding the trade balance are due to the different specifications employed.

Our results also clearly indicated substantial differences across the two sub-periods as to which factors are consistent and statistically significant. In a way, however, the sensitivity of the results to the sample is predictable and should not be considered as a deficiency. Given the

[6] Svensson (1993), Chen & Giovannini (1993), Rose & Svensson (1994), Thomas (1994), Rose & Svensson (1995).

[7] See Chapter 2 for more details on the methodology used by Jeanne & Masson (1998).

well-documented progress in the convergence within the EMS after 1987[1], it is no surprise that realignment expectations -marked by substantially lower volatility- should be linked to different variables.

6. 5. Results for the Italian Lira

6. 5. 1. Estimation of Realignment Expectations

Table 19 presents the OLS results for the estimation of expected movements in the lira-mark exchange rate within the fluctuation band over the period from March 1979 until August 1992[2]. It is found that the current exchange rate deviation from the central parity as well as its cubic term are statistically significant and have positive signs. The quadratic term, on the other hand, is not statistically different from zero. A likelihood ratio test for joint significance was computed and found equal to 68.94 with p-value=1.10e-16. Therefore, the null hypothesis that the non-linear terms are jointly statistically insignificant was rejected. The interest rate differential takes a negative and statistically significant coefficient; a high Italian interest rate relative to Germany is therefore associated with a lira appreciation. The Italian lira has 10 regimes corresponding to the 9 lira devaluations over the period. The dummy variables for regimes 2, 3, 4, and 9 are also statistically significant and positive[3] whilst the others are not statistically different from zero[4]. The goodness of fit of the equation is relatively high (R^2=78.17 percent).

As mentioned previously, the expected realignment rate should be interpreted as the product of the expected realignment size times the expected realignment frequency. Hence, a value of 30 percent per annum indicates that a realignment of 5 percent (the average ERM realignment size) has an expected frequency of 6 per annum - or a 50 percent probability of occurrence in the next month. One may note that the magnitude of the estimated expected movements within

[1] The sometimes known as Hard EMS experienced no realignment, more co-operation and monetary policy co-ordination.

[2] The sample period and therefore the number of observations is less for the lira than for the franc because the lira was taken out of the ERM in September 1992.

[3] This reflects a tendency for the exchange rate to be located at the lower edge of the band after a realignment, so that the lira depreciates over time to achieve mean reversion.

[4] In Rose & Svensson (1994) most regime intercepts are insignificant.

the band plotted in Figure 16 seems less than that showed in Figure 5d of Svensson (1993). Yet, the general patterns are relatively close. A possible explanation is that Svensson 's (1993) estimation equation differs from equation (7) and that Svensson estimates expected movements three months ahead.

Figure 17 plots the daily expected realignment rate time series. As in the case of the French franc, the estimated expected realignment rate is often very high and volatile in the early 1980s before becoming smaller and less volatile in the late 1980s. As a result of the differences in the estimates of expected exchange rate movements in the band, Figure 17 is not closely akin to Figure 8c in Svensson (1993). Figure 18 plots the monthly realignment expectations (i.e. the daily estimates averaged over each month). Clearly, although they tend to converge towards zero, the lira devaluation expectations remain positive over the whole period, and the lira is never as credible as the franc.

6. 5. 2. Estimation of the Markov Regime Switching Model with Fixed Transition Probabilities

Table 20a summarises the results of the regime switching model estimation with fixed transition probabilities for the full sample (March 1979 to August 1992). The normal regime is depicted by a small mean value of the realignment expectation associated with a small variance. The crisis state, on the other hand, has much larger mean and variance. The probabilities of remaining within a state are both very high (close to 100 percent). All parameters are statistically different from zero. The specification tests presented in Table 20b however suggest that serious autocorrelation and heteroskedasticity problems are present. Therefore, autoregressive specifications were examined. Table 20c presents the regime switching results for an AR(1) model. Lag orders higher than one did not prove statistically significant and, as Tables 20d shows, the problems of autocorrelation and heteroskedasticity were eliminated with the first order autoregressive model. In Table 20c, a normal state is associated with an expected realignment rate of 4.55 percent and a small variance 0.44, whilst the crisis state has a mean of 5.85 percent and a larger variance of 9.54. Both states have long expected duration. The normal regime lasts on average 24 months whilst the crisis state average duration is 16 months. As will be detailed below this is due to the low level of credibility in the early stages of the ERM. This also explains why the TP statistic computed from the model (TP=.3214) is higher than the benchmark TP ($\overline{TP}$=.0920). Finally, all the parameters are statistically significant at the 5 percent critical level.

Figure 20 plots the unconditional smoothed probabilities of being in the crisis state identified by the AR(1) model (Table 20c). One can distinguish four definite episodes of low and volatile credibility for the lira. Realignment expectations belong to the high level - high volatility regime in the early 1980s (more precisely from June 1979 until March 1983). In fact, the lira is devalued five times during this first episode and, as well documented in the literature, the ERM parities generally experience a serious lack of credibility. A second crisis episode starts in June 1985 and finishes in March 1986, a period during which the lira is devalued by 8 percent (1985M07), and the ERM comes under severe pressure due to the weakness of the dollar. Moreover the high realignment expectations of March 1986 precede the ninth realignment, when the lira is devalued by 3 percent. The third credibility collapse takes place between August and November 1987. Although there is no obvious justification for this identification, one may recall that high positive values for the lira realignment expectations also indicate expectations of revaluation for the German mark. The last crisis episode corresponds to the unprecedented summer 1992 ERM crisis, depicted here by high realignment expectations from June 1992 until the end of the sample (August 1992). Overall the identification of crisis months for the lira is relatively close to the actual history of the Italian currency. However, contrary to the comments of Rose and Svensson (1994), we believe that the 1992 lira crisis has been preceded by a gradual deterioration in its credibility as we find indications of a pending crisis as early as June 1992.

Note that, Andrews' test for a permanent shift in the mean crosses the critical values in April 1986 (see Figure 19). Consequently, the expected realignment rate and the regime switching model were estimated for the two sub-samples: March 1979-April 1986 and May 1986-August 1992. The results are presented in Appendices A6. It is indeed found that the means of the expected realignment rate decrease substantially from one period to the other (for both states, the means are three times higher in the first sample -Table A6.3c- than in the second -Table A6.5c). However, because the identification of the crisis episodes (as given by the unconditional smoothed probabilities plotted in Figures A6.1 and A6.2 based on the specifications of Table A6.3c and Table A6.5c, respectively) corresponds extremely closely to that of Figure 20, it was decided to pursue the investigation with the full sample (Table 20c) in order to keep maximum degree of freedom and avoid small sample problems. Additionally, the best specifications for the first sub-sample (Table A6.3c) were still subject to problems of autocorrelation.

Table 19: Estimation of the Future ITL/DEM Rate Within the Band: 1979 M03–1992M08

Sample(adjusted): 1 3198
Included observations: 13.03.79 – 12.08.92
Newey-West HAC Standard Errors & Covariance (lag truncation=8)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
x_t	0.646873	0.061831	10.46202	0.0000
x_t^2	0.002507	0.014466	0.173334	0.8624
x_t^3	0.007747	0.003132	2.473629	0.0134
δ_t	-0.062099	0.021078	-2.946120	0.0032
α_1: 13.03.79	-0.279753	0.267325	-1.046492	0.2954
α_2: 24.29.79	1.000283	0.210302	4.756420	0.0000
α_3: 24.03.81	0.535451	0.226445	2.364595	0.0181
α_4: 05.10.81	0.876645	0.329825	2.657908	0.0079
α_5: 14.06.82	0.064142	0.486603	0.131816	0.8951
α_6: 21.03.83	0.212634	0.280217	0.758821	0.4480
α_7: 22.07.85	0.238981	0.340340	0.702184	0.4826
α_8: 07.04.86	-0.163217	0.211897	-0.770266	0.4412
α_9: 12.01.87	0.838851	0.170663	4.915264	0.0000
α_{10}: 08.01.90	0.148574	0.090786	1.636536	0.1018

R-squared	0.781673	Mean dependent var	-0.257724
Adjusted R-squared	0.780781	S.D. dependent var	1.873740
S.E. of regression	0.877300	Akaike info criterion	2.580432
Sum squared resid	2450.582	Schwarz criterion	2.607006
Log likelihood	-4112.111	F-statistic	876.8930
Durbin-Watson stat	0.099395	Prob(F-statistic)	0.000000

Table 20a: Fixed Transition Probabilities Model

μ_n	μ_c	σ_n^2	σ_c^2	p_{nn}(%)	p_{cc}(%)	Lik./SC	MSE	TP
4.9455*	10.713*	3.7299*	11.861*	99.12*	98.23*	-240.63	50.9426	.423
[22.72]	[26.29]	[6.446]	[6.192]	[104.5]	[67.18]			

(*) denotes significance at the 5 percent level. Numbers in square brackets below the parameter estimates are t-statistics.

Table 20b: Specification Tests for the Static Model

White test F(4, 156)		LM Tests F(1, 158)	
Serial Correlation in both regimes	25.84*	Serial Correlation in regime n	69.61*
ARCH effects in both regimes	10.46*	Serial Correlation in regime c	36.19*
Markov Specification	15.85*	Serial Correlation across regimes	96.72*
		ARCH effects in both regimes	10.05*

The 5 percent critical values for the F(4, 156) and F(1, 158) are 2.40 and 3.87 respectively; and the 1 percent critical values are 3.36 and 6.73 respectively. (*) denotes significance at the 1 percent level; (**)denotes significance at the 5 percent level

Table 20c: AR(1) Model with ρ Constant Across States

μ_n	μ_c	ρ	σ_n^2	σ_c^2	p_{nn} (%)	p_{cc} (%)	Lik./SC	MSE	TP
4.455*	5.851*	.9497*	.4368*	9.537*	95.8*	93.78*	-133.1	25.75	.3214
[2.83]	[3.41]	[38.4]	[6.11]	[5.41]	[44.6]	[25.8]		9	

Table 20d: Box-Pierce Q-statistics on Residuals for Autocorrelation (A) and Heteroskedasticity (H)

	Q(1)	Q(2)	Q(3)	Q(4)	Q(5)	Q(6)	Q(7)	Q(8)	Q(9)	Q(10)	Q(20)
A	.7172	.7173	.9362	1.511	5.543	5.543	10.16	12.54	12.81	12.96	15.25
	[.397]	[.699]	[.816]	[.825]	[.353]	[.476]	[.179]	[.129]	[.171]	[.226]	[.762]
H	.198	2.016	2.025	2.642	4.604	4.856	5.897	8.57	9.044	9.347	27.03
	[.656]	[.365]	[.567]	[.619]	[.466]	[.562]	[.552]	[.379]	[.433]	[.499]	[.134]

$\chi^2(m)$ tests. p-values in square brackets. (*) denotes significance at the 5 percent level

Figure 16: Daily Lira Expected Devaluation Within the Band

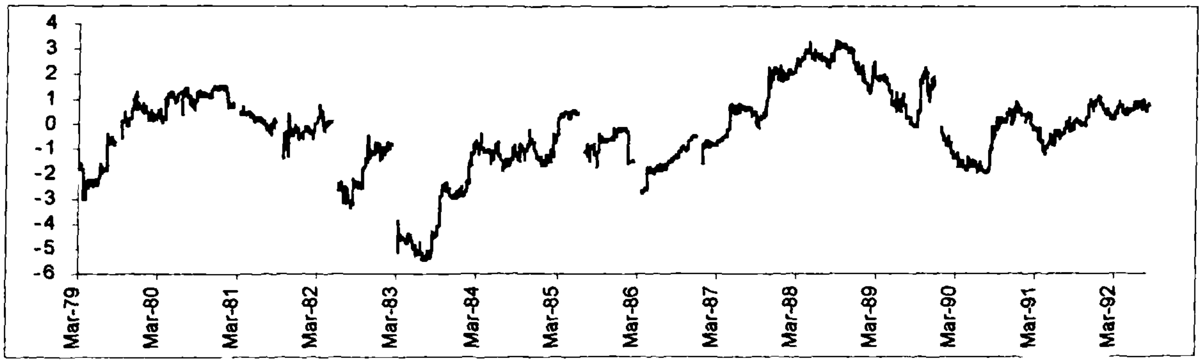


Figure 17: Daily Realignment Expectations for the Italian Lira

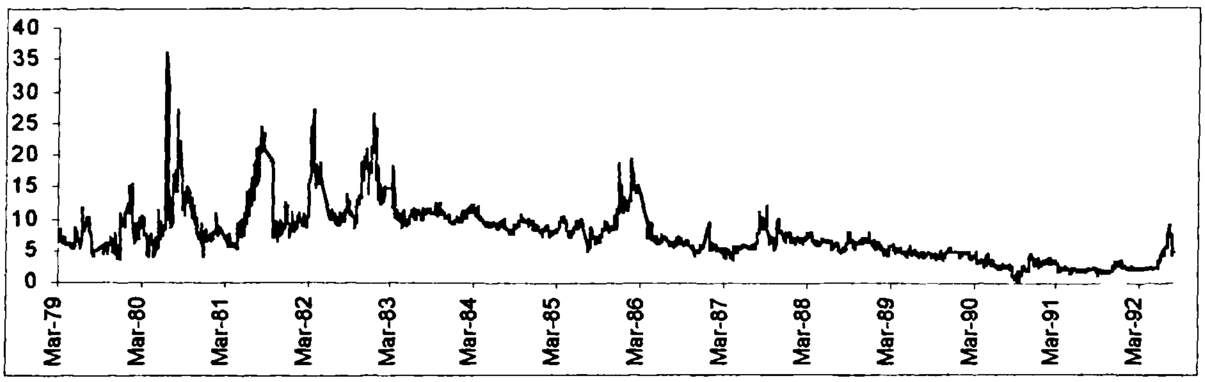


Figure 18: Monthly Realignment Expectations for the Italian Lira

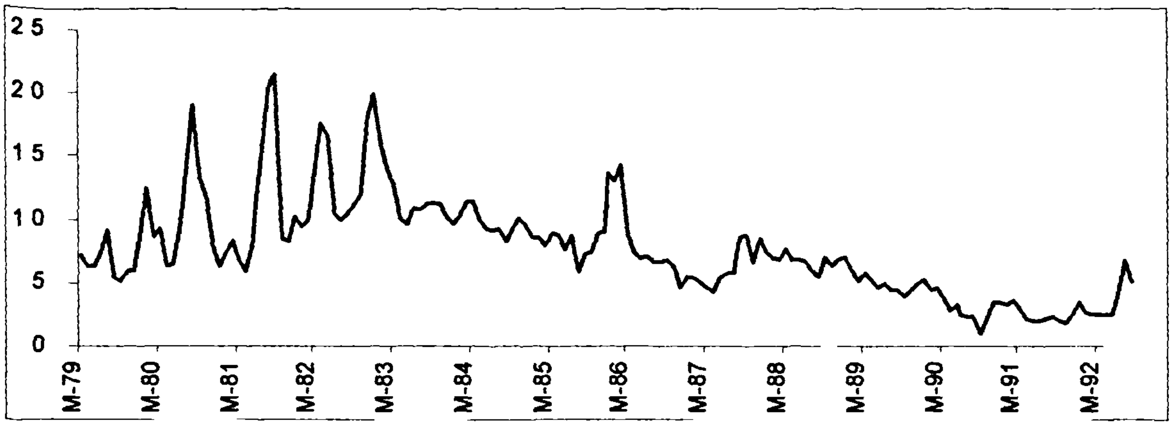


Figure 19: Andrews'Test for Permanent Shift in the Mean

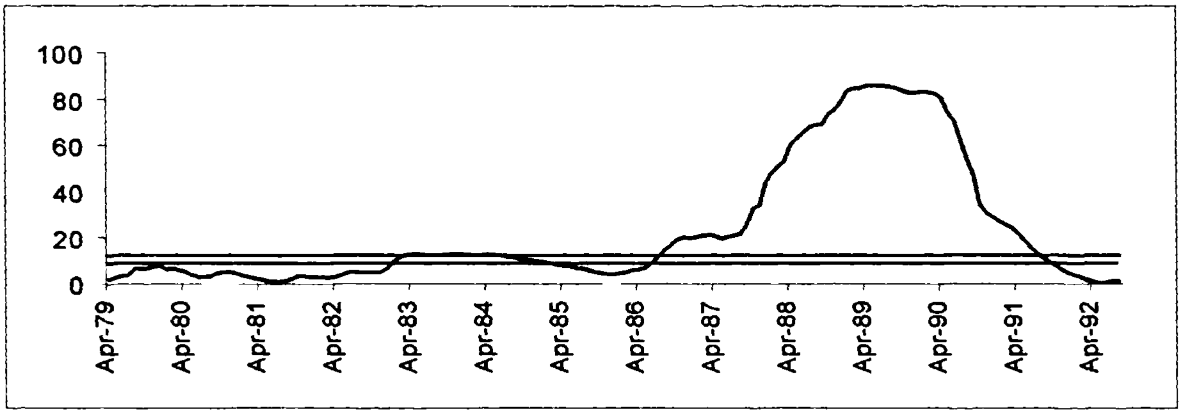
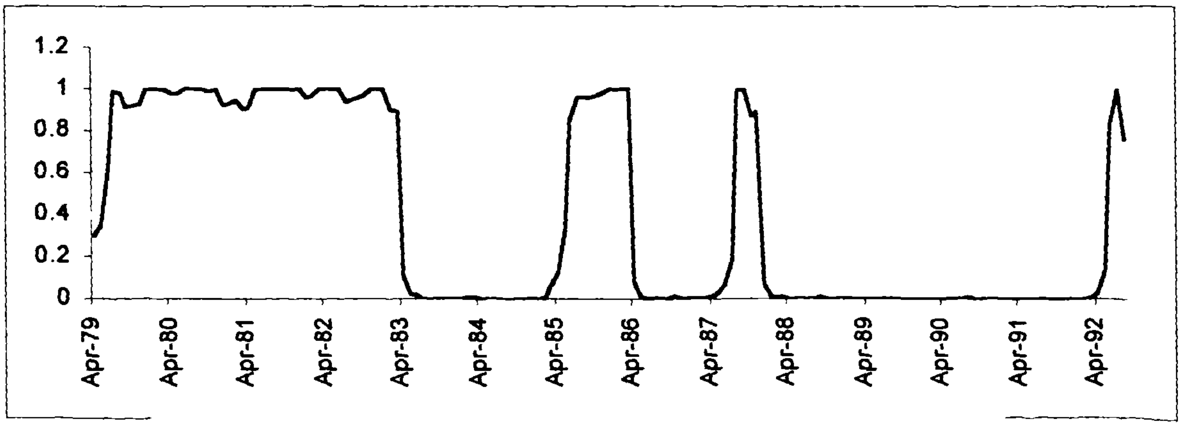


Figure 20: Smoothed Probabilities of Being in State c -AR(1) specification



6. 5. 3. Time-Varying Transition Probabilities: The Role of Economic Variables

Tables 21 to 26 present the findings on the effect of economic as well as external variables on lira realignment expectations. Numbers in square brackets below the parameter estimates are *t*-statistics. The means and variances in both the normal and crisis regimes ($\mu_n, \mu_c, \sigma_n^2, \sigma_c^2$), and the autoregressive coefficient, ρ_1, are all statistically significant and similar to the parameters shown in Table 26c for fixed transition probabilities. The fixed parameters of the probabilities of remaining in each regime, δ_n^0 and δ_c^0, are statistically significant and positive[1], suggesting that the expected realignment rate tends to remain in a given regime once it is in that regime.

Table 21 contains the inference regarding the current Italian economic variables and the German mark depreciation rate against the dollar. Two variables are statistically significant and display the correct signs: the change in the inflation rate, ΔINF in the normal regime; and the Trade Balance, TB, in the crisis state. Figure 21a plots the conditional probability of remaining in the normal regime, p_{nn}, with ΔINF as explanatory variable. The plot shows that p_{nn} is very volatile in the early 1980s (with values close to zero in 79M10&11, 80M01, 02, 08, & 12, 81M04 and 82M08&09) and then remains high and stable. Therefore, increases in inflation clearly contribute to the crises (realignments) of the early 1980s. More precisely, if ΔINF exceeds 0.655 percent -as Figure I1 (Appendix 4.2.) shows it is the case in the early 1980s- p_{nn} falls below 0.5. By contrast, the higher TB, the less likely it is that the expected realignment rate will remain high and volatile (the trigger value for p_{cc} to fall below 0.5 is TB–0.1065). p_{cc}, plotted in Figure 21b, exhibits some volatility. It is however relatively high during the whole period, to the exception of a few occasions when it takes values lower than 0.5[2]. As to the remaining results, the parameters for the probability of transition from the crisis state are statistically significant for DEBT, M2/R and ΔDM$ but do not take the expected sign. Conversely, some indicators display the correct signs but are statistically insignificant (ΔGDP in both states; M2/R, TB and ΔDM$ in the normal regime, and ΔINF in the crisis state).

[1] Exceptions for δ_n^0 include the cases of DEBT, and M2RD in Tables 28 and 32, whilst δ_c^0 is not significantly different from zero for TB in Tables 27, 28, 30, ΔRERD in Tables 28, 30 and 32, M2RD in Table 28 and ΔDM$ in Table 34.

[2] These are 79M09, 85M08, 86M08&09, 87M09 and 91M01.

Finally, the remaining parameters are statistically insignificant and theoretically inconsistent: ΔIP and ΔRER in both regimes, and DEBT in the normal state.

Table 22 summarises the results for current differentials between Italian and German variable. One of the indicators is statically significant and correctly signed: ΔRERD in the crisis regime. When the Italian competitiveness deteriorates compared to Germany (in particular if ΔRERD exceeds 0.37percent), it is more probable that realignment expectations will remain high and volatile. Figure 21c plots p_{cc} as a function of ΔRERD. p_{cc} is close to one in the first half of the sample, then falls between 86M06 and 88M06, after which date it increases gradually until the end of the 1989 and finally fluctuates slightly till the end of the sample. The coefficient on DEBT is also statistically different from zero in the crisis regime but does not have the anticipated sign. Conversely, ΔINFD, M2/RD and ΔGDPD display the correct signs in the normal state but are statistically insignificant. All the other indicators are both statistically insignificant and theoretically incorrect (IPD and TBD in both regimes; DEBTD and ΔRERD in the normal state; ΔINFD, M2/RD and ΔGDPD in the crisis state).

Table 23 presents the findings on the one-month-lagged Italian economic variables and German mark depreciation rate against the dollar. Two indicators are correctly signed and statistically significant: ΔINF and ΔDM$ in the normal state. Hence, the lower ΔINF, the higher p_{nn}. The plot of p_{nn} as a function of one month-lagged ΔINF in Figure 21d is -naturally- closely related to Figure 21a which is the corresponding plot for the current ΔINF. Therefore, the conclusions are the same as above: the lira was subject to serious inflationary pressure in the early 1980s which probably contributed to the frequent adjustments of its central parity whilst subsequent improvement in inflation helped enhancing the credibility of the lira (the trigger value for one-month-lagged ΔINF is 0.596 percent). In turn, if the German mark depreciation rate against the dollar raises above -7.05 percent, p_{nn} exceeds 0.5. Figure 21e plots p_{nn} as a function of one-month-lagged ΔDM$. Despite a few exceptions (81M11, 86M06&12, 87M03 and 88M01), the probability is high throughout the entire period[3] because ΔDM$ is always above its trigger value (see Figure F9 in Appendix 4.1). The coefficients on DEBT and M2/R are also

[3] The plot of ΔDM$ is given in Appendix 4.1. (Figure F9) and shows that ΔDM$ is almost constantly above the trigger value.

statistically significant in the crisis state but they are not correctly signed. On the other hand, although some indicators have the correct signs (ΔIP and TB in both states; M2/R in the normal regime; and ΔINF in the crisis state), their coefficients are not statistically significant. Finally, all the other parameters on one-month-lagged variables display the wrong signs and are not statistically different from zero (ΔRER and ΔGDP in both states, DEBT in the normal regime and ΔDM$ in the crisis regime).

Table 24 presents the results on the explanatory power of one-month-lagged differentials between the Italian and German indicators. Only one of the proposed differentials is both theoretically correct and statistically significant: ΔINFD in the normal regime. That is, the lower the inflation rate differential, the more likely it is that devaluation expectations will stay low and stable. As a result the plot of p_{nn} for one-month-lagged ΔINFD in Figure 21f is akin to those of Figures 21a and 21d (the trigger value is ΔINF−0.655 percent). Note however that p_{nn} in Figure 21f plunges to lower values on three more occasions than in Figure 21d (i.e. 85M12, 87M11 and 90M03) stressing the importance of the *differential* between the Italian and German inflation rates. DEBTD and M2/RD are also statistically significant in the crisis state but they are not correctly signed. By contrast, the indicators that display the correct signs (IPD, ΔRERD and TBD in the two regimes, M2/RD in the normal regime, ΔINFD and ΔGDPD in the crisis state) are not statistically significant. Lastly, the remaining parameters are insignificant in statistical terms and theoretically inconsistent (DEBTD and ΔGDPD in the normal regime).

Table 25 shows the estimation results as to the two-month-lagged Italian economic variables and German mark depreciation rate against the dollar. Once again, the only indicator that proves statistically significant and theoretically consistent at the same time is the change in inflation in the normal regime. Thus, a decrease in the two-month-lagged inflation rate prolongs the regime of stable and low realignment expectations. Clearly, the plot of p_{nn} conditional on the evolution of ΔINFD in Figure 21g suggests the same inference as Figures 21a, and 21d (the trigger value of two-month-lagged ΔINFD is 0.779 percent). Two other indicators are statistically significant in the crisis regime: DEBT and M2/R. However, the signs of their coefficients are not as theoretically anticipated. On the other hand, a few parameters are correctly signed but not statistically different from zero: TB and M2/R in the normal state; as well as ΔINF and ΔIP in the crisis regime. Finally, the remaining two-month-lagged variables are both statistically insignificant and theoretically incorrect (ΔRER, ΔGDP and ΔDM$ in both regimes, DEBT and ΔIP in the normal regime, and TB in the crisis state).

Table 26 summarises the findings regarding the two-month-lagged differentials between the Italian and German indicators. None of the indicators displays the anticipated signs and is statistically significant. DEBTD, TBD and M2/RD are statistically significant in the crisis regime but they do not have the expected signs. Conversely, some indicators are correctly signed - ΔRERD in both states; DEBTD, TBD, M2/RD in the normal regime; IPD and ΔGDPD in the crisis regime - but the coefficients are not statistically different from zero. The rest of the two-month-lagged differentials are neither statistically significant nor theoretically consistent. These include ΔINFD in both regimes, IPD and ΔGDPD in the normal state.

Table 21: Z_t = **Current Italian Variables and External Variable**

	DEBT	ΔINF	ΔIP	ΔRER	TB	M2/R	ΔGDP	ΔDM$
μ_n	4.7395* [3.052]	4.3574* [2.719]	4.4120* [2.761]	4.6600* [3.056]	4.4342* [2.212]	4.5955* [2.958]	4.4592* [2.827]	4.447* [2.851]
μ_c	6.3184* [3.595]	5.6589* [3.198]	5.8161* [3.358]	6.1676* [3.583]	5.1766* [2.432]	6.2726* [3.720]	5.8543* [3.408]	5.9739* [3.589]
ρ	.9477* [37.77]	.9502* [38.85]	.9502* [38.63]	.9475* [37.46]	.9606* [37.07]	.9493* [38.07]	.9497* [38.38]	.9494* [37.61]
σ_n^2	.6689* [11.16]	.6586* [12.33]	.6592* [12.24]	.6668* [11.57]	.6520* [11.93]	.6676* [11.79]	.6611* [12.17]	.6548* [12.21]
σ_c^2	3.1171* [10.53]	3.0958* [10.84]	3.0868* [10.83]	3.1294* [10.53]	3.1569* [10.29]	3.0794* [10.93]	3.0888* [10.71]	3.0763* [10.97]
δ_n^0	1.4134 [.407]	3.4685* [4.716]	3.1800* [5.539]	2.0103* [2.772]	3.4338* [2.361]	5.1397* [3.243]	3.1058* [4.671]	3.2791* [5.531]
δ_n^1	2.0349 [.474]	-5.29** [-1.871]	-.1024 [-.360]	.2370 [1.466]	5.9409 [.558]	-4.1847 [-1.502]	.0084 [.052]	.1249 [.436]
δ_c^0	8.7104* [2.447]	2.6226* [4.369]	2.7258* [4.388]	2.6846* [3.559]	1.1776 [1.574]	7.8226* [2.645]	2.7123* [4.289]	3.4567* [3.586]
δ_c^1	-9.35** [-1.892]	.1692 [.177]	.0076 [.069]	-.2799 [-1.505]	-11.05** [-1.955]	-8.018* [-2.129]	-.0019 [-.018]	.3877** [1.698]
Lik.	-130.29	-131.19	-133.04	-130.39	-131.19	-128.92	-133.09	-132.5
MSE	71.2539	71.3288	71.2766	72.2128	71.5359	71.3856	71.282	71.2951
TP	.337456	.330417	.313997	.215423	.290202	.33982	.312641	.336241

Table 22: Z_t = **Current Differences in the Italian and German Variables**

	DEBTD	ΔINFD	IPD	ΔRERD	TBD	M2/RD	ΔGDPD
μ_n	4.7511* [3.108]	4.4930* [2.855]	4.3942* [2.743]	4.4586* [2.811]	4.4960* [2.891]	4.5630* [2.898]	4.5425* [2.946]
μ_c	6.3082* [3.670]	5.8398* [3.304]	5.8177* [3.391]	5.9764* [3.523]	5.9069* [3.492]	6.3024* [3.691]	5.9074* [3.509]
ρ	.9468* [37.32]	.9497* [38.56]	.9506* [39.14]	.9505* [39.86]	.9493* [38.19]	.9498* [39.10]	.9488* [37.75]
σ_n^2	.6689* [11.18]	.6633* [12.09]	.6568* [12.39]	.6572* [12.31]	.6626* [12.23]	.6716* [12.08]	.6695* [12.06]
σ_c^2	3.1128* [10.59]	3.1004* [10.74]	3.0818* [10.89]	3.0931* [10.84]	3.0936* [10.79]	3.0538* [11.12]	3.1205* [10.83]
δ_n^0	2.3689 [.856]	3.0482* [5.689]	3.1740* [5.791]	2.9309* [2.884]	2.4362* [2.281]	1.7023 [.726]	3.8424* [4.241]
δ_n^1	1.1388 [.254]	-1.7602 [-.871]	-.0825 [-.449]	.0205 [.1993]	-3.1519 [-.672]	-1.1483 [-.715]	.0536 [1.337]
δ_c^0	7.3515* [2.428]	2.6800* [4.162]	2.7751* [4.327]	-.1027 [-.092]	2.8399 [1.303]	-9.7426 [-1.093]	2.7368* [4.654]
δ_c^1	-10.2** [-1.695]	-.2077 [-.261]	.0691 [.459]	.2875* [2.367]	.4571 [.062]	-12.699 [-1.302]	.0026 [.063]
Lik.	-130.67	-132.71	-132.91	-131.05	-132.87	-130.89	-132.84
MSE	71.2609	71.2936	71.2668	71.3501	71.2666	71.3456	71.2729
TP	.33912	.31523	.317916	.318726	.313514	.356209	.344599

Table 23: Z_t **= Lagged Italian Variables and External Variable (1 lag)**

	DEBT	ΔINF	ΔIP	ΔRER	TB	M2/R	ΔGDP	ΔDM$
μ_n	4.8022* [3.081]	4.6325* [3.111]	4.4016* [2.694]	4.8411* [3.122]	4.7882* [2.558]	4.5797* [3.045]	4.4999* [2.825]	4.961* [4.420]
μ_c	6.3798* [3.645]	5.9987* [3.674]	5.7846* [3.245]	6.4524* [3.626]	6.2665* [3.062]	6.2224* [3.853]	5.9184* [3.417]	5.5799* [4.589]
ρ	.9484* [37.81]	.9468* [35.75]	.9521* [39.18]	.9486* [37.77]	.9563* [27.68]	.9473* [35.72]	.9506* [38.52]	.9289* [41.05]
σ_n^2	.6671* [11.23]	.6702* [11.48]	.6536* [12.53]	.6691* [11.28]	.6749* [11.07]	.6749* [11.39]	.6598* [12.18]	.7119* [12.86]
σ_c^2	3.1126* [10.59]	3.1601* [10.41]	3.0871* [10.88]	3.1412* [10.38]	3.1400* [8.726]	3.0935* [10.91]	3.0861* [10.88]	3.1232* [10.71]
δ_n^0	1.8028 [.487]	3.5265* [4.767]	3.4844* [4.931]	1.9337* [2.490]	4.8201* [2.843]	4.6968* [3.402]	3.1567* [5.105]	4.2706* [3.378]
δ_n^1	1.5605 [.3437]	-5.916* [-2.437]	.4297 [1.502]	.2532 [1.423]	13.433 [1.196]	-3.2693 [-1.279]	-.0060 [-.051]	.6054** [1.929]
δ_c^0	8.6467* [2.426]	2.4789* [3.577]	2.8189* [4.231]	2.6164* [3.296]	1.8877* [2.139]	9.9424* [2.705]	2.7908* [4.298]	237.92 [.297]
δ_c^1	-9.17** [-1.852]	1.2587 [1.264]	-.0153 [-.085]	-.2859 [-1.331]	-4.2131 [-.399]	-11.19* [-2.398]	.0198 [.205]	53.73 [.292]
Lik.	-130.01	-128.81	-131.45	-130.21	-130.15	-127.09	-132.46	-130.2
MSE	71.4714	71.5969	71.4906	73.3973	71.3400	71.5939	71.4956	71.6080
TP	.342072	.311289	.321554	.313775	.295114	.33563	.346975	.329694

Table 24: Z_t**=Lagged Differences Between the Italian and German Variables (1 lag)**

	DEBTD	ΔINFD	IPD	ΔRERD	TBD	M2/RD	ΔGDPD
μ_n	4.7909* [3.127]	5.3857* [4.009]	4.4537* [2.780]	4.5454* [2.857]	4.5082* [2.807]	4.6097* [2.960]	4.4557* [2.753]
μ_c	6.3388* [3.733]	7.2235* [4.731]	5.8981* [3.426]	6.0107* [3.408]	5.9777* [3.365]	6.3805* [3.861]	5.8738* [3.387]
ρ	.9476* [37.39]	.9437* [31.63]	.9509* [39.35]	.9506* [38.70]	.9509* [38.92]	.9494* [38.11]	.9512* [38.82]
σ_n^2	.6664* [11.34]	.7113* [10.84]	.6560* [12.28]	.6616* [11.99]	.6601* [12.14]	.6799* [12.69]	.6577* [12.33]
σ_c^2	3.1074* [10.68]	3.2886* [9.417]	3.0827* [10.94]	3.0918* [10.81]	3.0865* [10.87]	3.0857* [11.01]	3.0819* [10.91]
δ_n^0	2.6867 [.985]	3.3212* [4.203]	3.1939* [5.719]	3.2053* [2.902]	3.6287* [2.564]	2.1995 [1.028]	3.0205* [5.225]
δ_n^1	.6353 [.145]	-5.07** [-1.918]	.0757 [.406]	-.0106 [-.101]	1.8268 [.387]	-.8207 [-.569]	-.0198 [-.485]
δ_c^0	7.2095* [2.460]	1.7243* [2.939]	2.8477* [4.305]	.5637 [.372]	2.4374 [1.284]	-23.9** [-1.789]	2.8509* [4.215]
δ_c^1	-9.76** [-1.679]	.6456 [.849]	-.0378 [-.228]	.2203 [1.489]	-1.4939 [-.208]	-28.1** [-1.871]	-.0195 [-.463]
Lik.	-130.39	-130.12	-132.38	-131.27	-132.37	-127.54	-132.30
MSE	71.4781	71.2356	71.4675	71.2136	71.5698	71.8614	71.4888
TP	.344406	.262497	.322382	.318342	.319282	.347051	.323558

Table 25: Z_t = **Lagged Italian Variables and External Variable (2 lags)**

	DEBT	ΔINF	ΔIP	ΔRER	TB	M2/R	ΔGDP	ΔDM$
μ_n	4.6455* [2.990]	5.1191* [2.699]	4.3648* [2.659]	4.5790* [2.893]	4.4589* [2.699]	4.4305* [2.622]	4.4681* [2.832]	4.4548* [2.692]
μ_c	6.1840* [3.652]	6.1915* [2.927]	5.7807* [3.276]	6.1146* [3.569]	5.9094* [3.312]	5.8017* [3.256]	5.9179* [3.460]	5.9394* [3.290]
ρ	.9487* [38.39]	.9589* [33.98]	.9521* [40.16]	.9499* [39.27]	.9519* [38.13]	.9526* [35.22]	.9502* [38.88]	.9519* [39.44]
σ_n^2	.66202* [11.79]	.6858* [10.12]	.6501* [12.71]	.6597* [12.02]	.6614* [12.02]	.6671* [11.67]	.6579* [12.33]	.6573* [12.16]
σ_c^2	3.1059* [10.84]	3.2427* [9.891]	3.0839* [11.05]	3.1068* [10.79]	3.1184* [10.67]	3.1287* [1057]	3.0957* [10.95]	3.0957* [10.87]
δ_n^0	2.9507 [1.170]	3.2007* [4.978]	3.3503* [5.125]	2.8453* [2.849]	4.2458* [3.809]	4.6543* [3.581]	3.5427* [4.626]	3.1678* [5.724]
δ_n^1	.1835 [.061]	-4.108* [-2.275]	-.2098 [-.716]	.0479 [.256]	3.1799 [1.440]	-3.5658 [-1.627]	-.1127 [-.894]	-.0943 [-.391]
δ_c^0	8.7759* [2.558]	2.2039* [3.747]	3.1676* [4.343]	3.0031* [3.901]	3.1799* [2.507]	14.08* [2.223]	2.9238* [4.494]	3.2230* [3.845]
δ_c^1	-9.01** [-1.919]	.7822 [.757]	-.1789 [-1.249]	-.2455 [-1.453]	2.5299 [.391]	-18.29* [-2.114]	.0196 [.185]	.2930 [1.255]
Lik.	-129.59	-129.15	-130.84	-130.84	-130.69	-125.02	-131.31	-130.8
MSE	71.7005	71.7461	71.6418	71.5418	71.6802	71.8135	71.6808	71.7289
TP	.352327	.280817	.340973	.335267	.321929	.331429	.328208	.347464

Table 26: Z_t=**Lagged Differences Between the Italian and German Variables (2 lags)**

	DEBTD	ΔINFD	IPD	ΔRERD	TBD	M2/RD	ΔGDPD
μ_n	4.6412* [3.003]	4.4019* [2.725]	4.3635* [2.632]	4.4896* [2.823]	4.5062* [3.625]	4.3471* [2.435]	4.4238* [2.691]
μ_c	6.1688* [3.678]	5.8466* [3.361]	5.6687* [2.956]	5.9751* [3.686]	5.6487* [4.163]	5.5168* [2.609]	5.7677* [3.173]
ρ	.9484* [38.26]	.9509* [39.38]	.9519* [38.41]	.9502* [38.88]	.9349* [40.59]	.9548* [33.03]	.9515* [37.41]
σ_n^2	.6618* [11.84]	.6559* [12.35]	.6537* [12.53]	.6612* [11.94]	.6817* [12.79]	.6596* [12.27]	.6599* [12.09]
σ_c^2	3.1054* [10.85]	3.0899* [10.98]	3.0889* [10.99]	3.1031* [10.80]	3.1132* [10.85]	3.1066* [10.79]	3.1029* [10.81]
δ_n^0	3.2116 [1.595]	3.2394* [5.176]	3.1919* [5.725]	3.6803* [3.288]	4.2699* [2.676]	2.1991 [1.005]	2.9703* [5.340]
δ_n^1	-.1755 [-.055]	.3797 [.234]	-.0738 [-.347]	-.0603 [-.632]	3.4557 [.688]	-.7333 [-.521]	-.0317 [-.931]
δ_c^0	7.1659* [2.682]	2.9958* [4.439]	3.0899* [4.258]	.7671 [.533]	13.562* [2.442]	-17.5** [-1.814]	2.8556* [4.241]
δ_c^1	-9.25** [-1.807]	-.3292 [-.364]	-.1477 [-.948]	.2111 [1.457]	30.714* [2.157]	-20.5** [-1.971]	-.0126 [-.272]
Lik.	-129.93	-131.64	-131.24	-130.38	-128.53	-126.05	-131.37
MSE	71.6967	71.6957	71.6724	71.7016	71.7836	71.8219	71.7022
TP	.352776	.352622	.35073	.34516	.337283	.354282	.347225

Figure 21a: p_{nn} ΔINF_t

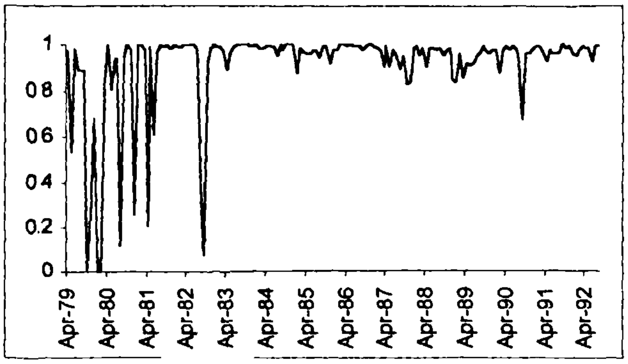


Figure 21b: p_{cc} ΔTB_t

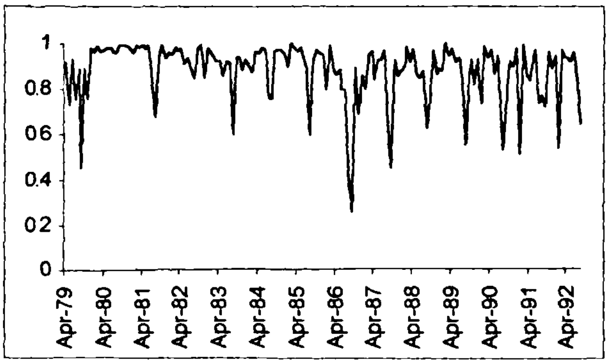


Figure 21c: p_{cc} $\Delta RERD_t$

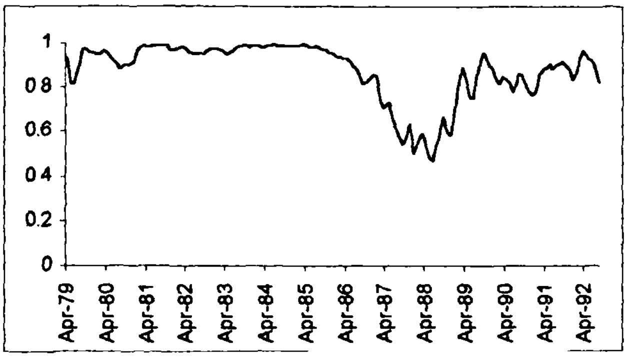


Figure 21d: p_{nn} ΔINF_{t-1}

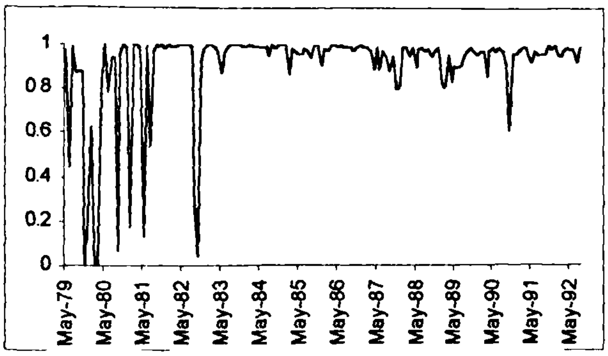


Figure 21e: p_{nn} $\Delta DM\$_{t-1}$

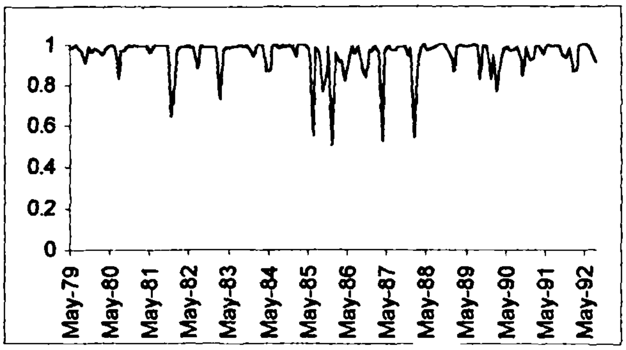


Figure 21f: p_{nn} $\Delta INFD_{t-1}$

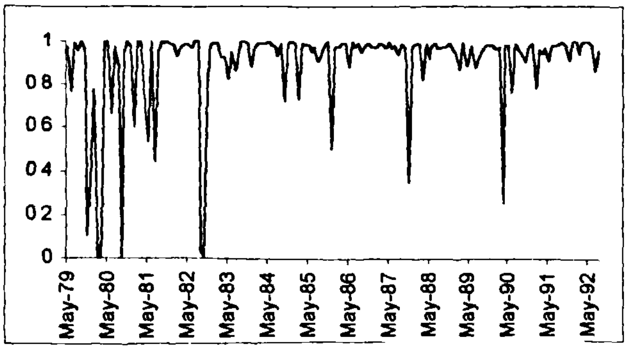
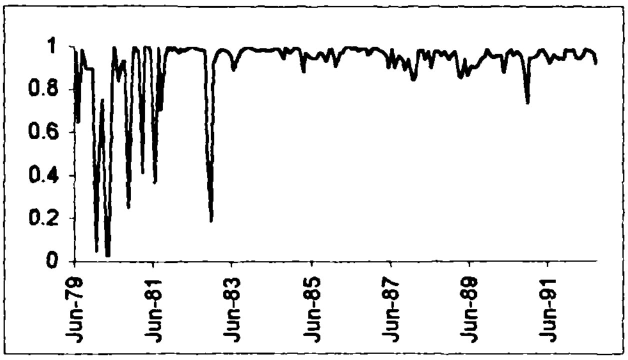


Figure 21g: p_{nn} ΔINF_{t-2}



6. 5. 4. Conclusions on the Italian Realignment Expectations

The expected realignment rate for the Italian lira has been estimated using the drift-adjustment methodology as the preliminary step of the exercise. In accordance with other studies[4], it was found that expectations of lira devaluation against the DEM were positive for most of the period from 1979 to 1992.

The results of the regime switching regime model with fixed transition probabilities (MSM-FTP) showed that the expected realignment rate follows two regimes: a state of low and stable expectations (the so-called normal regime) and a state of high and volatile expectations (or crisis regime). The classification of each observation as a crisis or tranquil month - on the basis the unconditional probabilities of being in each state - proved effective in the sense that it corresponds closely to well-known events for the Italian lira. Consequently, we investigated the extent to which a set of economic indicators could affect the transitions between states.

As in the first sub-sample for the French franc, the inference is only weak since -with the exception of inflation- there does not appear to be theoretically consistent and statistically significant links between shifts in the expected realignment rate and most of the crisis indicators. Indeed, a significant relationship was found only with current, one and two-month-lagged changes in domestic inflation (plus the one-month-lagged differential change in inflation) and the one-month lagged mark depreciation rate against the dollar in the normal regime, the current domestic change in competitiveness relative to Germany and the one-month-lagged trade balance in the crisis state. Hence, debt, industrial production, GDP growth and the ratio of M2 to reserves up to three lags do not have any theoretically consistent impact on the shifts between the two regimes.

These findings, albeit weak, are comparatively superior to Rose & Svensson's (1994) who find that "of the variables that we examine, only inflation differentials vis-à-vis Germany affect ERM realignments in a systematic way". Furthermore, our results contradict Thomas (1994) who finds that inflation and competitiveness are not significant and that the influence of debt is only ambiguous and Tronzano (1999) who concludes that the inflation differential is either incorrectly signed or insignificant. Indeed, although the study by Tronzano (1999) is the most related to this chapter (it applies a different Markov regime switching model to the Italian interest rate differential with Germany) it does not exactly lead to the same conclusions. By contrast to the results presented in this chapter, Tronzano (1999) shows that industrial production affects both the credible and "not credible" states. Two other variables in Tronzano (1999) -the real exchange rate and the current account balance- are found significant in determining the transitions from the credible (low differential) state whilst they affect the crisis regime in this chapter[5]. These differences could possibly be due to the differences in the model, dependent variable and sample period (Tronzano applies an AR(1) model with constant variance on the Italian vs. German interest rate differential from January 1990 until August 1995). Overall, it appears that the poor explanatory power of macroeconomic fundamentals regarding realignment expectations is a common feature of most studies of the lira.

6. 6. Conclusions

The objective of Chapter six was twofold. First we proposed to estimate realignment expectations for the Italian lira and the French franc and secondly we aimed to investigate any potentially significant economic determinant of the speculative attacks against the two currencies. More precisely, we examined whether with switches of realignment expectations between a stable and a crisis regime are associated with changes in economic, financial and external variables.

To sum up, we found significant ties between switches of realignment expectations and some macroeconomic indicators (especially for the franc in the period 1987-1993)[6]. It however proved difficult to find systematic links between the expected realignment rate and most of the chosen indicators. We nonetheless regard these results as encouraging when compared to the

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[4] Svensson (1993), Chen & Giovannini (1993), Rose & Svensson (1994), Thomas (1994), Rose & Svensson (1995).

[5] Note, moreover, that in Tronzano (1999) the conditional probability of remaining in the credible state does not fall below 78 percent for the real exchange rate, 52 percent for the current account balance (for one observation in mid-1991) and 68 percent for output growth (the transition probability is actually close to unity except for one observation in 1995 when it falls to 68 percent) whilst our results suggest a more volatile relationship for ΔRERD and ΔTB.

[6] We found significant channels of influence from inflation, unemployment, output growth and debt on the French crises. Conversely, an improvement in French competitiveness, trade balance, and debt differential with Germany and a dollar appreciation seem to strengthen the credibility of the franc. As far as the Italian lira is concerned, lower inflation, and a dollar appreciation against the German mark help remaining in the high credibility state; whilst a fall in competitiveness compared to Germany and a deteriorating trade balance tend to keep the lira in the crisis regime.

well-know failure of most empirical studies to characterise the relationship between currency credibility and macroeconomic variables[7]. Chapter 6 is close in spirit to Chen & Giovannini (1993), Thomas (1994), Rose & Svensson (1994), Jeanne (1997) and Jeanne & Masson (1998), all of which try to test the relationship between macroeconomic variables and exchange rate credibility. Yet our results only corroborate the conclusions of the latter two studies for the French franc. As far as the Italian lira is concerned, the conclusions drawn in this chapter diverge from those of Tronzano (1999) in the sense that we do not identify the same indicators of currency crises.

It can moreover be remarked that the significant and consistent indicators of regime switches are generally different for the index of exchange market pressure from those regarding realignment expectations. A comparison of the results presented in Chapters 5 and 6 for the French index of exchange market pressure and realignment expectations, respectively, shows that the channels through which the explanatory variables are related to speculative pressure against the franc are different. Their timing and the state they influence, in particular, do not exactly match. For example, whilst debt and the German mark depreciation rate versus the dollar play a role in the determination of shifts in the realignment expectations, they did not prove significant in the case of the exchange market pressure index. Yet, some of the estimations conducted on the expected realignment rate in Chapter 6 corroborate the conclusion in Chapter 5 that changes in unemployment, output growth (in terms of real GDP or industrial production), real exchange rate, trade balance and inflation affect the transition probabilities between states.

In the case of Italy, it is interesting to note that, contrary to the results obtained with the index of exchange market pressure in Chapter 5, the ratio of debt to GDP, the ratio of M2 to reserves and output growth did not prove important in explaining regime switches for the realignment expectations in Chapter 6. Conversely, whilst the real exchange rate and trade balance were found to be meaningful factors for realignment expectations, they did not play any role for the index of EMP. The only partial exception to this statement, for Italy, is the inflation differential although it affects the normal state of the expected realignment rate and the crisis regime of the index of EMP.

[7] For a thorough survey of exchange rate determination, see Taylor (1995a).

Finally, this last observation reminds us that a notable finding in Chapters 5 and 6 is that the chosen indicators generally affect the two states differently. In fact, each exogenous variable typically affects one state but not the other. This draws attention to the fact a currency is not equally vulnerable to the evolution of economic variables whether it is in a tranquil or crisis regime, and therefore justifies *-ex-post-* the use of the two-state model.

Table A1: Realignment Dates

Dates	France		Italy	
	Central parity	Real. in percent	Central parity	Real. in percent
79/03/13	2.30950	--	457.314	--
79/09/24	2.35568	1.96*	466.460	1.96*
81/03/23	--	--	496.232	6.00
81/10/05	2.56212	8.06*	539.722	8.06*
82/06/14	2.83396	9.59*	578.574	6.79*
83/03/21	3.06648	7.58*	626.043	7.58*
85/07/22	--	--	679.325	7.84
86/04/07	3.25617	5.83*	699.706	2.91*
87/01/12	3.35386	2.91*	720.699	2.91*
90/01/08	--	--	748.217	3.68% and switch to narrow band
92/09/16	--	--		6.54% and float
93/08/01	--	widening of ERM bands	--	--

An asterisk denotes a devaluation as part of a in a general realignment.

Table A2: Estimation of the Future ITL/DEM Exchange Rate Within the Band: 1979M03 – 1986M04

Sample: 1 1650
Included observations: 13.03.79 – 14.06.82
Newey-West HAC Standard Errors & Covariance (lag truncation=7)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
x_t	0.506712	0.089069	5.688973	0.0000
x_t^2	-0.071952	0.050004	-1.438922	0.1504
x_t^3	-0.001247	0.008401	-0.148420	0.8820
δ_t	-0.043444	0.023452	-1.852482	0.0641
α_1: 13.03.79	-0.458681	0.326598	-1.404422	0.1604
α_2: 24.29.79	1.055857	0.255397	4.134176	0.0000
α_3: 24.03.81	0.495504	0.225997	2.192528	0.0285
α_4: 05.10.81	0.655841	0.348775	1.880412	0.0602
α_5: 14.06.82	-0.098771	0.466844	-0.211571	0.8325
α_6: 21.03.83	0.037272	0.356707	0.104488	0.9168
α_7: 22.07.85	0.129373	0.308139	0.419853	0.6746
α_8: 07.04.86	-0.998797	0.365635	-2.731678	0.0064

R-squared	0.719297	Mean dependent var	-0.949738
Adjusted R-squared	0.717412	S.D. dependent var	1.915174
S.E. of regression	1.018088	Akaike info criterion	2.880976
Sum squared resid	1697.793	Schwarz criterion	2.920311
Log likelihood	-2364.806	F-statistic	381.5765
Durbin-Watson stat	0.096293	Prob(F-statistic)	0.000000

Table A3a: Estimation of the FTP Model: 1979 M03 – 1986M04

μ_n	μ_c	σ_n^2	σ_c^2	p_{nn}(%)	p_{cc}(%)	Lik./SC	MSE	TP
8.7783*	15.412*	3.0869*	9.6658*	92.21*	72.22*	-124.86	4.5486	.236
[36.77]	[15.85]	[5.277]	[2.592]	[26.65]	[6.703]			

(*) denotes significance at the 5 percent level.

Table A3b: Specification Tests for the Static Model

White test F(4, 80)		**LM Tests** F(1, 79)	
Serial Correlation in both regime	6.6923*	Serial Correlation in regime n	25.033*
ARCH effects in both regimes	.43938	Serial Correlation in regime c	3.5661
Markov Specification	5.8649*	Serial Correlation across regimes	27.367*
		ARCH effects in both regimes	2.0908

The 5 percent critical values for the F(4, 80) and F(1, 79) are 2.50 and 3.97 respectively; and the 1 percent critical values are 3.59 and 7.00 respectively. (*) denotes significance at the 1 percent level; (**)denotes significance at the 5 percent level.

Table A3c: AR(1) Model with ρ Constant Across States

μ_n	μ_c	ρ	σ_n^2	σ_c^2	p_{nn}(%)	p_{cc}(%)	Lik./SC	MSE	TP
9.451*	11.07*	.7147*	.7669*	12.51*	85.14*	81.25*	-102.63	13.869	.2592
[14.96]	[9.374]	[11.92]	[2.702]	[3.448]	[10.35]	[5.519]			

Table A3d: Box-Pierce Q-statistics on Residuals for Autocorrelation (A) and Heteroskedasticity (H)

	Q(1)	Q(2)	Q(3)	Q(4)	Q(5)	Q(6)	Q(7)	Q(8)	Q(9)	Q(10)	Q(20)
A	2.8346 [.092]	2.8629 [.239]	4.4811 [.214]	7.1992 [.126]	13.86* [.016]	13.94* [.030]	16.06* [.025]	19.19* [.014]	19.19* [.024]	20.28* [.027]	22.74 [.302]
H	.0433 [.835]	.0626 [.969]	.5012 [.918]	1.6208 [.805]	6.2386 [.284]	6.4317 [.377]	6.6289 [.468]	6.7112 [.568]	7.3094 [.605]	7.6197 [.666]	11.76 [.924]

$\chi^2(1)$ tests. P-values in square brackets. (*) denotes significance at the 5 percent level

Table A3e: AR(1) Model with ρ Dependent on State

μ_n	μ_c	ρ_n	ρ_c	σ_n^2	σ_c^2	p_{nn}(%)	p_{cc}(%)	Lik./SC	MSE	TP
8.888* [12.7]	12.70* [11.9]	.8709* [9.45]	.5512* [5.36]	.7229* [3.15]	10.87* [3.70]	86.08* [54.2]	79.04* [23.9]	-101.4	66.88	.24562

(*) denotes significance at the 5 percent level

Figure A1: Smoothed Probabilities of Being in State c for the AR(1) Model: 1979M03-1986M04

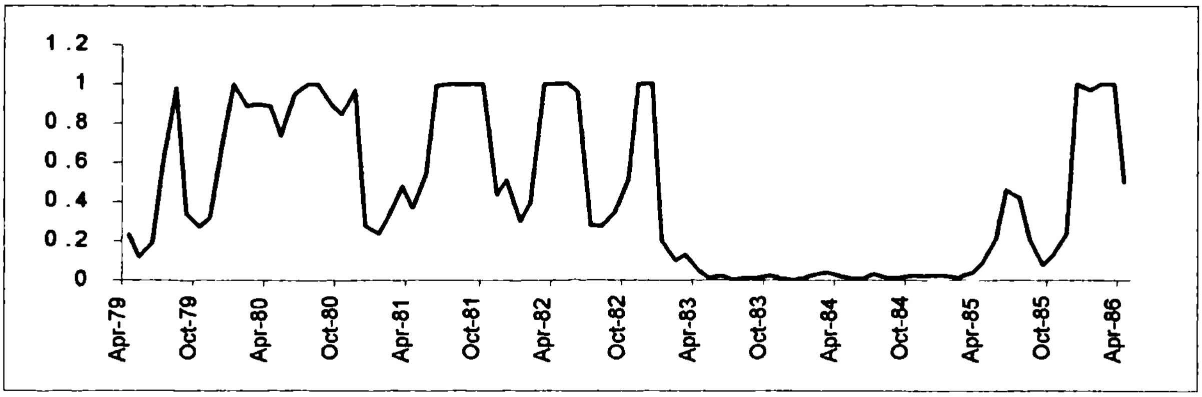


Table A4: Estimation of the Future ITL/DEM Exchange Rate Within the Band: 1986M05 - 1992M08

Sample(adjusted): 1651 3198
Included observations: 14.06.82 – 12.08.92
Newey-West HAC Standard Errors & Covariance (lag truncation=7)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
x_t	0.836537	0.068478	12.21617	0.0000
x_t^2	-0.010082	0.036781	-0.274098	0.7840
x_t^3	0.002549	0.013118	0.194302	0.8460
δ_t	-0.092442	0.044480	-2.078303	0.0378
α_8: 07.04.86	0.545838	0.289064	1.888297	0.0592
α_9: 12.01.87	0.876740	0.305761	2.867405	0.0042
α_{10}: 08.01.90	0.271987	0.116653	2.331595	0.0199
R-squared	0.829478	Mean dependent var		0.479888
Adjusted R-squared	0.828814	S.D. dependent var		1.513485
S.E. of regression	0.626199	Akaike info criterion		1.906215
Sum squared resid	604.2653	Schwarz criterion		1.930384
Log likelihood	-1468.411	F-statistic		1249.324
Durbin-Watson stat	0.090777	Prob(F-statistic)		0.000000

Table A5a: Estimation of the FTP Model: 1986M05 - 1992M08

μ_n	μ_c	σ_n^2	σ_c^2	p_{nn}(%)	p_{cc} (%)	Lik./SC	MSE	TP
2.573*	5.926*	.3984*	1.436*	95.34*	98.44	-42.974	3.1791	.5919
[20.15]	[34.22]	[3.369]	[4.905]	[24.75]	[60.68]			

(*) denotes significance at the 5 percent level.

Table A5b: Specification Tests for the Static Model

White test $F(4, 71)$		**LM Tests** $F(1, 70)$	
Serial Correlation in both regimes	12.162*	Serial Correlation in regime n	9.2983*
ARCH effects in both regimes	3.2309*	Serial Correlation in regime c	19.077*
Markov Specification	*	Serial Correlation across regimes	26.279*
	14.836*	ARCH effects in both regimes	.57242

The 5 percent critical values for the $F(4, 71)$ and $F(1, 70)$ are 2.51 and 3.98 respectively; and the 1 percent critical values are 3.62 and 7.04 respectively. (*) denotes significance at the 1 percent level; (**)denotes significance at the 5 percent level.

Table A5c: AR(1) Model with ρ Constant Across States

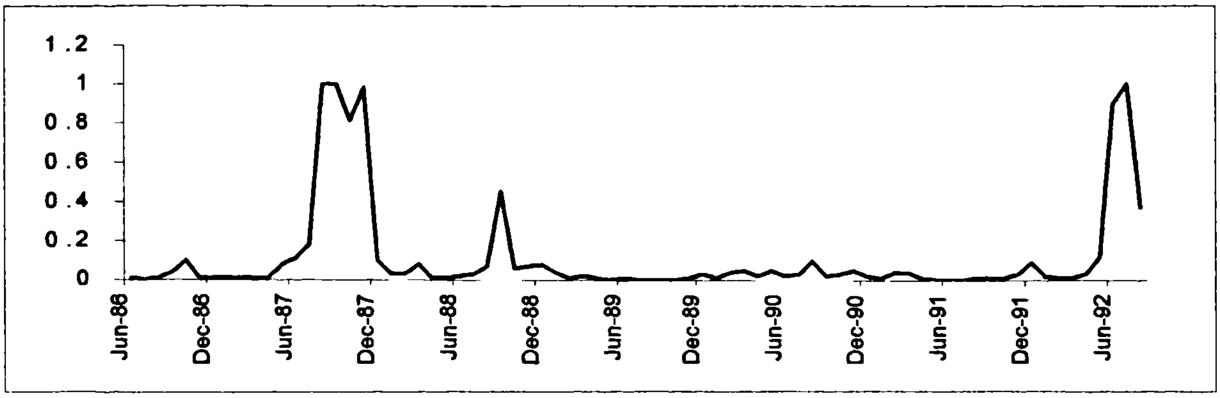
μ_n	μ_c	ρ	σ_n^2	σ_c^2	p_{nn} (%)	p_{cc} (%)	Lik./SC	MSE	TP
3.601*	4.656*	.9169*	.3272*	2.32**	95.08*	63.11*	-14.71	5.4325	.1564
[3.58]	[3.88]	[23.0]	[4.59]	[1.76]	[22.3]	[2.13]			

Table A5d: Box-Pierce Q-statistics on Residuals for Autocorrelation (A) and Heteroskedasticity (H)

	Q(1)	Q(2)	Q(3)	Q(4)	Q(5)	Q(6)	Q(7)	Q(8)	Q(9)	Q(10)	Q(20)
A	.0271	.3926	5.892	6.073	8.335	11.05	11.17	11.36	11.73	11.79	19.83
	[.869]	[.822]	[.117]	[.194]	[.139]	[.087]	[.131]	[.182]	[.229]	[.299]	[.469]
H	.5592	.7627	3.464	4.278	4.411	4.411	4.469	4.698	4.859	4.994	9.021
	[.455]	[.683]	[.326]	[.369]	[.492]	[.621]	[.724]	[.789]	[.846]	[.892]	[.983]

$\chi^2(1)$ tests. P-values in square brackets. (*) denotes significance at the 5 percent level

Figure A2: Smoothed Probabilities of Being in State c for the AR(1) Model: 1986M05 - 1992M08



Chapter 7

Political Parties and Currency Crises: A Theoretical and Empirical Analysis

7. 1. Introduction

A common criticism of second generation models is that they do not explain how a large number of investors simultaneously co-ordinate their actions. This is why most economists agree that external forces and, particularly, political factors play a crucial role in the determination of the shifts in expectations[1]. In the case of sterling, for example, Eichengreen & Hsieh (1995) note that "Our comparison of the 1931 and 1992 crises suggest that prominent political events with obvious economic consequences can serve as focal points and play a catalytic role." It is also certainly not a coincidence that the severe speculative attacks against the French franc in 1981, 1986 and 1993 took place in the context of uncertainty about the outcome of French general elections. Likewise, there is no doubt that political uncertainties have, on several occasions, put pressure on the Italian lira (particularly in 1992).

Despite overwhelming informal evidence that political news and events determine shifts in expectations, it is still tacitly assumed in most models of currency crises that governments stay in office forever. The primary motivation of this chapter is to show that uncertainty about policymakers' objectives resulting from political factors (such as elections) can affect the equilibrium of currency crisis models. The objective is to discuss the interaction between the presence of two political parties -with differing objectives and incentives- and shocks to fundamentals. More precisely, the proposed analysis consists in bringing together Obstfeld's (1994) second model of currency crises and Alesina's (1987) "Rational Partisan" approach of political business cycles, in a framework à la Barro & Gordon (1983).

In Partisan models, political parties have different preferences about unemployment and inflation. The Partisan theory dates from the proposition of Hibbs (1977) that left wing governments care less about inflation than about unemployment. Alesina (1987) shows that, if wage-setters have rational expectations about the policymaker's incentives, a Socialist administration will bring higher inflation, but not lower unemployment than a Conservative one. Political business cycles can yet arise because the interaction between the unpredictability of electoral outcomes[2] and rational expectations leads to policy shocks with temporary (post-election) output effects. Before the election, inflationary expectations are a weighted average of the expectations under left- and right-wing administrations with weights corresponding to the respective probabilities of election. If the Socialists win, expectations will have been too low so that real wages and unemployment subsequently fall (hence a transitory expansion) and, vice versa, if the Conservatives win, there will be a transitory contraction. Either way, adjustment to the policymaker takes place in the following years and unemployment returns to its natural rate. In other words, the theory predicts temporary real effects and permanent partisan inflation effects. Hence the result that, under a Socialist government, inflation and nominal wage growth are higher but unemployment is not lower than under a Conservative administration.

In Obstfeld (1994), devaluations may result from a government decision to offset severe negative shocks to competitiveness and employment. However, a shift in the market's sentiment regarding the government's willingness to tolerate commonly known economic shocks may also force a devaluation that would not have occurred under different private expectations. In the proposed model, by contrast, the crucial determinant of speculative pressure will be the political nature of the decision to devalue, combined with uncertainty about election outcomes.

The analysis presented in this chapter is therefore partially related to Jeanne (1997), in which the government may take a soft or tough stance. In Jeanne's model, the peg is defended whatever the circumstances if the policymaker takes a tough stance whilst if the government takes a soft stance, it will decide to abandon the current parity as soon

[1] See, for example, Jeanne & Masson (1998), Krugman (1998), Obstfeld (1995), Kregel (1994), Eichengreen et al. (1995).

as the net benefit of the peg is negative. Having said that, the possibility that the policymaker may be in either mood does not determine the equilibria of Jeanne's model and is only useful in the empirical part of the paper whilst it takes importance from a theoretical point of view in our analysis.

The empirical part of this chapter attempts to test the hypotheses derived from the proposed model. Very few empirical studies investigate the importance of political factors in currency crises. Eichengreen et al. (1995, 1996) test whether changes in government, in prime minister, and finance minister are linked to speculative attacks and devaluations. They also attempt to determine whether currency crises are more likely to occur before or after elections and whether left- or right-wing governments are more propitious to speculative attacks. Although Eichengreen et al. find some evidence that a new government that has defeated its predecessor is more likely to abandon a fixed exchange rate arrangement, most of the results are ambiguous.

In line with Chapters 5 and 6, the Markov regime switching model with time varying transition probabilities is applied to the index Exchange Market Pressure and to the drift-adjusted devaluation expectations for the French franc and Italian lira. The objective is to show that the introduction of a political dimension -the presence of two political parties, the uncertainty about their true type and the occurrence of elections- affects the probabilities of shift between tranquil and crisis episodes.

The present chapter is organised as follows. Section 2 sets out a model based on Obstfeld (1994), within which the importance of the policymaker's political tendency is discussed as in Alesina (1987). Section 3 illustrates graphically the mechanisms of currency crises described in the previous section. Section 4 provides an empirical inspection of the model using two case studies: the French franc and the Italian lira. Section 5 summarises the main findings and concludes.

7. 2. A model of currency crisis

[2] Uncertainty can also exist about the type of government (i.e. wet or dry), or about its competence.

7. 2. 1. Framework

The assumptions underlying the analysis are as follows. There is perfect capital mobility and perfect asset substitution so that a realignment is the sole instrument of monetary policy. Purchasing Power Parity holds so that the log of the exchange rate (the home-currency price of foreign exchange), e, equals the log of the money price of domestic output, p, with the log of the foreign-currency price level, p^*, constant and normalised to zero. No distinction is made between the government and the central bank, i.e. the party in office decides on monetary policy. An equilibrium is defined as a fixed point in the reciprocal mapping between the actions of the elected political party and the beliefs of participants in the foreign exchange market.

In this framework, domestic output, y, is given by:

$$y_t = \alpha(e_t - w_t) - u_t \tag{1}$$

where w is the money wage and u is a mean-zero, serially independent shock to the economy such as, for example, a public or private demand shifts, or a change in foreign interest rates. All lower case variables denote natural logarithms[3].

The following explains the interaction between the rational, perfectly informed, forward-looking private sector and the two parties.

In the first move of the game, wage setters agree, on date t-1, to set wages for period t so as to maintain the real wage constant. Hence,

$$w_t = E_{t-1}(e_t) \tag{2}$$

where $E_{t-1}(\cdot)$ is a conditional expectation based on full and accurate information available at date t-1, so that the wage is not indexed to the value of the demand shock that occurs in period t, u_t.

[3] Assuming a production function $Y = AL^{\beta}$ where A is a positive constant that includes fixed capital and β is a positive fraction, the natural logarithm of output, $y = a + \beta l$, is linearly positively related to labour, which therefore implicitly enters the government's objective function.

Acting second, the policymaker -unless it is infinitely "tough"- will react to period t shocks by altering the exchange rate by surprise, through a so-called stabilisation policy. Stabilisation policy is a general term employed to describe government's programs to prevent or shorten recessions and to counteract inflation, by using the basic tools of aggregate supply and aggregate demand analysis. In this specific context, the stabilisation policy consists of exploiting the potential short-run Phillips trade-off between wage inflation and unemployment. The idea is that inflation -or devaluation-expectations are fixed in the short-run so that any surprise change in inflation (any surprise devaluation) will be unexpected and therefore will bring unemployment down (because unexpected inflation reduces real wages)[4].

However, wage-setters understand the policymaker's motivation to use the short-run trade-off relationship between inflation and unemployment and, therefore, set the nominal wage so as to deter any intention to initiate a surprise devaluation. This means that, in equilibrium and in the absence of any binding commitment, the policymaker cannot influence employment.

Following Alesina (1987), let us now introduce two political parties, party L (the Socialist party) and party C (the Conservatives), who commit to different optimal policies and whose incentives to initiate a stabilisation policy differ.

More precisely, party L is more sensitive than party C to the cost of unemployment and thus has a stronger incentive to trigger a devaluation. Besides, party L is more willing than party C to use money creation to respond to unpredictable negative output shocks; i.e. party L's optimal inflation rate is higher than party C's.

7. 2. 2. Optimisation Problem

Let us initially assume that the exchange rate is floating freely. The objective of party L is to minimise a loss function that penalises deviations of the inflation rate from a target of zero, and deviations of output from a target equal to y^*:

[4] In the long-run, by contrast, expectations are correct, unemployment is determined by real variables and insensitive to inflation.

$$\pounds_t^L = \sum_{s=t}^{\infty} \beta^{s-t}[\theta(e_s - e_{s-1})^2 + (y_s - y^*)^2] \tag{3}$$

where β, $0<\beta<1$, is the government's discount factor, θ measures the commitment to exchange rate stability[5], and y^* is strictly positive. y^* can be thought as representing the distortions in the labour market (e.g. taxes, or monopolistic unions that keep the real wage higher than necessary to maximise the welfare of union members) that would bring the equilibrium output level below the efficient level.

Putting equations (1) and (3) together, party L's flow loss for period t, l_t^L, can then be expressed as:

$$l_t^L = \frac{\theta}{2}(e_t - e_{t-1})^2 + \frac{1}{2}[\alpha(e_t - w_t) - u_t - y^*]^2 \tag{4}$$

The optimisation problem goes as follows. Each party will choose the home currency's exchange rate, e_t, each period so as to minimise its flow loss function, l_t, given the nominal wage rate agreed in period $t-1$. Minimisation of the Socialist party's loss function -equation (4)- over e_t requires that $\frac{\partial l_t^L}{\partial e_t} = \theta(e_t - e_{t-1}) + \alpha[\alpha(e_t - w_t) - u_t - y^*] = 0$.

Defining λ to be $\lambda = \alpha^2/(\theta + \alpha^2)$, one gets the following (discretionary) one-shot Nash equilibrium reaction function for party L[6]:

$$\hat{\Pi}_t^L = (e_t - e_{t-1}) = \lambda(w_t - e_{t-1}) + \lambda(y^*/\alpha) + \lambda(u_t/\alpha) \tag{5}$$

where $\hat{\Pi}_t^L$ can be viewed as the optimal depreciation rate for the Socialist party, given the private sector's expectations about the future exchange rate.

Equation (5) tells that party L tends to use the exchange rate partially in order to make up for shocks and to raise output, but also that the equilibrium size of the realignment increases with λ, the measure of the L party's softness (the higher is λ, the softer the party).

[5] The higher θ, the higher the government resolve to keep the parity fixed.

[6] The model can be viewed as a game because the two agents in the economy -the government and the private sector- who both understand each other's preferences and act strategically. A Nash equilibrium refers to an equilibrium where each player is doing the best it can, given what its competitors are doing

By contrast, party C is infinitely tough so that its loss function is $\pounds_t^C = \sum_{s=t}^{\infty} \beta^{s-t}[(e_t - e_{t-1})^2]$ and its optimal choice is to keep the exchange rate fixed at all times, i.e. $\hat{\Pi}_t^C = (e_t - e_{t-1}) = 0$.

7. 2. 3. Devaluation Thresholds

What follows aims to explore an exchange rate system with "escape clause" that allows the government to realign in periods of economic stress at a cost to the policymaker in power. The basic assumption is that, because a credible pre-commitment is not possible in the absence of an enforceable and irrevocable fixed peg agreement, the domestic policymaker attempts to solve its credibility problem by adopting a "fixed but adjustable" peg and exposing itself to a fixed cost of realignment, *c*. In this framework, *c* may account for the degree of political commitment, government credibility, or the institutional support put behind the fixed exchange rate arrangement. In actual institutional terms, an increase in *c* in the model might represent the convergence of the EMS towards EMU. From the point of view of a Socialist administration, the period loss function becomes:

$$l_t^L = \frac{\theta}{2}(e_t - e_{t-1})^2 + \frac{1}{2}[\alpha(e_t - w_t) - u_t - y^*]^2 + cZ_t \qquad (6)$$

Using Obstfeld's (1994) terminology, agents form memoryless expectations so that Z_t is a dummy equal to unity if a realignment takes place; and zero otherwise. Again, the policymaker will minimise its loss function, given a pre-determined nominal wage rate - that is, a pre-determined expected depreciation rate: $\Pi_t^e = w_t - e_{t-1}$.

If the socialist policymaker anticipates to maintain the exchange rate fixed, its perceived loss before the elections of time t is $l_t^{L,F} = \frac{1}{2}(\alpha\Pi_t^e + u_t + y^*)^2$. If, instead, the policymaker intends to realign the peg, its faces a loss given by

$l_t^{L,R} = \frac{1}{2}(1-\lambda)(\alpha\Pi_t^e + u_t + y^*)^2 + c$ (where F and R stand for fixed and realigned, respectively).

Since the Socialist party's decisions today will not affect the future, a realignment will occur under a Socialist administration whenever the net short-run loss between keeping the rate fixed and realigning, $l_t^{L,F} - l_t^{L,R}$, is positive; that is, whenever: $l_t^{L,F} - l_t^{L,R} = \frac{1}{2}\lambda(\alpha\Pi_t^e + u_t + y^*)^2 - c > 0$, or:

$$(\alpha\Pi_t^e + u_t + y^*) > \sqrt{2c/\lambda} \tag{7}$$

Following Obstfeld (1994), it is assumed temporarily that revaluations are not possible[7]. Transforming equation (7) into an equality, one can solve for its roots to find the conditions for the shock u to be an equilibrium realignment threshold, $\bar{u}$. The disturbance shock is assumed to be uniformly distributed over the interval $[-\mu,\mu]$. In equilibrium, therefore, the expected value of $\bar{u}$ is the highest value of the shock at which the party in office still considers optimal to defend the domestic currency[8].

The timing of the game is as follows. In an election year, polls are taken in period t-1. Party L is expected to win the election with probability P and party C with probability (1-P). After the polls are taken, wage contracts are signed for period t. The elections take place at the beginning of period t, after which the elected government chooses its optimal inflation rate. In an election period, the expected devaluation rate for period t, given that the private sector believes on date t-1 that the devaluation will occur when $u_t > \bar{u}$ and the L party is elected is:

$$\Pi = \mathrm{P}\left[\Pr\{u_t \le \bar{u}\}.0 + \Pr\{u_t > \bar{u}\}.E\{e_t - e_{t-1} / u_t > \bar{u}\}\right] \tag{8}$$

[7] Obstfeld (1997) argues that this assumption accurately depicts devaluation-prone countries (e.g. most ERM member countries) while making the algebra more manageable.

[8] The rational expectation assumption requires that the policymaker's decision to devalue is optimal given the market beliefs and, vice versa, market expectations are rational given the actions of the policymaker.

where P is the probability that the socialist party will be elected[9] and $E\{e_t - e_{t-1} / u_t > \bar{u}\}$ denotes the expected value - at date t-1 - of the devaluation in the next period, conditional on the shock exceeding the trigger value[10]:

$$E\{e_t - e_{t-1} / u_t > \bar{u}\} = \lambda\Pi + \lambda\left(\frac{\mu + \bar{u}}{2\alpha}\right) + \lambda(y^* / \alpha) \qquad (9)$$

Note that because the conservative party is infinitely tough (i.e. it will never devalue), the expected devaluation rate for period t in equation (8) implicitly include the probability that party C will be elected (1-P) times the probability that party C will realign the exchange rate, which is zero.

In a non-election period, if the administration is Socialist, then Π simple becomes equal to $\left[\Pr\{u_t \leq \bar{u}\}.0 + \Pr\{u_t > \bar{u}\}.E\{e_t - e_{t-1} / u_t > \bar{u}\}\right]$ - as in Obstfeld (1994) - whilst if the administration is Conservative, Π is zero.

7. 2. 4. Equilibria

Let us now concentrate on the effect of political factors (elections) on the equilibrium of the model and consider only the case where there is an election in period t[11]. Define $\delta(\bar{u})$ as the equilibrium expected depreciation rate when the elected Socialist government would hold the exchange rate fixed for $u < \bar{u}$, but devalue otherwise, reduces to:

$$\delta(\bar{u}) = \lambda P\left(\frac{\mu - \bar{u}}{2\mu}\right)\left[\left(\frac{\mu + \bar{u}}{2\alpha}\right) + (y^* / \alpha)\right] \div \left[1 - \lambda P\left(\frac{\mu - \bar{u}}{2\mu}\right)\right] \qquad (10)$$

[9] Although it seems an interesting extension to endogenise the probability of each party to be elected, reverting to the consumers' preferences as to the trade-off between inflation and unemployment would require a set of assumptions on the probability distribution of these preferences.

[10] Under the assumed uniform distribution, the probability that the shock exceeds the trigger value is $\Pr\{u_t > \bar{u}\} = \frac{\mu - \bar{u}}{2\mu}$; and $E\{u_t / u_t > \bar{u}\} = \frac{\mu + \bar{u}}{2}$

[11] The solution to the model in a non-election period is given in Obstfeld (1994).

This government would then minimise its loss given the expectations in equation (10). According to equation (7)[12], the largest shock consistent with a fixed exchange rate is therefore the solution $\tilde{u}$ to the equation $\Gamma(\bar{u}) = (\alpha\delta(\bar{u}) + \tilde{u} + y^*) \equiv \mathrm{K} = \sqrt{2c/\lambda}$. Recalling that it was assumed that revaluations are not possible - i.e. that $\Gamma(u) > 0$ - and given that in equilibrium $\tilde{u} = \bar{u}$, the condition for $\bar{u}$ to be an equilibrium devaluation threshold is that:

$$(\alpha\delta(\bar{u}) + \bar{u} + y^*) = \sqrt{2c/\lambda} \quad i.e.\, \Gamma(\bar{u}) = \mathrm{K} \tag{11}$$

Multiple equilibria arise in the setting because the function $\Gamma(u)$ is non-monotonic. Non-monotonicity reflects the tension between two factors. As the shock threshold $\bar{u}$ rises, expected devaluation eventually falls, lowering the first summand of $\Gamma(u)$. However, the rise in $\bar{u}$ directly raises the second summand. Therefore, when the incentive to devalue under pure discretion is high, the devaluation expectation effect can outweigh the direct effect over some ranges of $\bar{u}$, making $\Gamma(u)$ alternatively increasing, decreasing and increasing.

Solving equation (10) for P, the probability that the L party is elected, one finds the values of P between which there are two equilibrium values of u that trigger a realignment (we denote them as $\bar{u}_1$ and $\bar{u}_2$)[13]. A measure of stability of the regime is the distance between these equilibrium values of u, $D = \bar{u}_2 - \bar{u}_1$[14]. Calculating the first order derivative of the square distance[15], D^2, with respect to P, one obtains:

$$\frac{d(D^2)}{d(P)} = \frac{16\mu^2}{\lambda^2 P^3}\left(\frac{\lambda}{\mu}(y^* + \mu)P - 2\right) \tag{12}$$

[12] The devaluation decision depends on u_t only because no other variable in the model enters the policy-maker's cost-benefit analysis.

[13] See Appendix 7 2 for details of the derivation of the equilibria. Note that these are the two interior solutions studied in Obstfeld (1994) but there is an additional "corner solution" where the government is always expected to devalue. This is further discussed later in the chapter.

[14] $D = \left(\frac{4\mu}{P\lambda}\right)\sqrt{\frac{\lambda c}{2\mu^2}P^2 - \left(\frac{\lambda}{\mu}y^* + \lambda\right)P + 1}$.

[15] We use the square because it simplifies the mathematics.

Hence, since $\lambda<1$, $\frac{\lambda}{\mu}(y*+\mu)P<2$ and it is assumed that a rational government aims at a minimum positive fixed target output loss no greater than the limit disturbance shock, μ (i.e. $y^*<\mu$), equation (12) suggest that the first order derivative of the distance, D, with respect to the probability that the Socialist party will elected, P, is negative (i.e. $\frac{d(D)}{d(P)}<0$).

In summary, multiple equilibria may arise in the setting because the fixed exchange rate threshold function $\Gamma(\bar{u})=(\alpha\delta(\bar{u})+\tilde{u}+y^*)$ is non-monotonic. Non-monotonicity reflects the tension between two factors. As the shock threshold $\bar{u}$ rises, expected inflation eventually falls, lowering the first term of $\Gamma(u)$. However, this rise directly raises the second term. Therefore, when the incentive to devalue under pure discretion is high, the devaluation expectation effects can outweigh the direct effect over some ranges of $\bar{u}$, making $\Gamma(u)$ alternatively increasing, decreasing and increasing.

The conceptual premise for the theory of self-fulfilling behaviour is that the stability of the exchange rate regime is affected by switches among the possible equilibria. In the present framework, the likelihood and extent of instability is represented by the distance between the equilibria, D, and we showed that the lower the probability of the Socialist party being elected, the higher instability - the larger D. More precisely, it is more likely that there will be a realignment of the exchange rate as the probability of the Socialist party being elected increases. When the latter probability falls, the range of possible equilibria increases in the sense that it is less certain that a realignment will be decided.

7. 2. 5. Graphical Illustration

Figure 1a represents the equilibrium expected depreciation rate, $\delta(u)$, on the vertical axis against the output shock, u. Figures 1b to 3 draw the intersections of the transformed equilibrium net loss function $\Gamma(u)=\alpha\delta(u)+u+y^*$ with the transformed devaluation cost $K=\sqrt{2c/\lambda}$ ($\Gamma(u)$ and K are scaled on the vertical axis and plotted against the shock, u, on the horizontal axis). The parameters used are $\alpha = 1, y^* = 0.01$ and $\mu = 0.03$ (these are the same as Obstfeld (1994)).

Figure 1b shows that in a situation where the left-wing government will definitely be elected (i.e. P=1) and is rather soft (θ=0.15), there exist two threshold values of the shock. One, say $\bar{u}_1 = -0.02$, corresponds to a devaluation expectation $\delta(\bar{u}_1) = 0.04$ (or 4 percent). The other, $\bar{u}_2 = 0.003$ is associated with a lower devaluation expectation[1], $\delta(\bar{u}_2) = 0.017$. This means that if the market believes that $\bar{u}_1$ is the devaluation threshold, then the policymaker will ratify that belief rather than tolerate its effect on output under the fixed peg system. Yet the market may also believe that $\bar{u}_2$ is the devaluation threshold, so that abandoning the peg is optimal for a wide range of output shocks, including favourable but small ones[2]. For P=0.90, there exists only one equilibrium: $\bar{u}_3$ =0.009. Note that as P decreases further, there may be no interior solution (i.e. $\Gamma(u) < \mathrm{K}$) so that an unconditional fixed exchange rate peg will prevail. Yet for a sufficiently high value of the transformed devaluation cost (K>0.047 in Figure 1b), the exchange rate is perfectly credible at the upper limit of the shock to the right.

In Figure 2, for a softer Socialist candidate (θ = 0.11), there will be one single equilibrium threshold for P = 0.995 corresponding to a shock $\bar{u}_4 = -0.0075$ associated with $\delta(\bar{u}_4)$=0.027. For P= .95, on the other hand, there are two thresholds: $\bar{u}_5$=-0.024 associated with $\delta(\bar{u}_5)$=0.044, and $\bar{u}_6$ = 0.0028 with $\delta(\bar{u}_6)$=0.0167. It is interesting to note here that $\Pr\{u_t > \bar{u}_4\}$=0.62, $\Pr\{u_t > \bar{u}_5\}$= 0.90and $\Pr\{u_t > \bar{u}_6\}$= 0.45 so that the realisation of equilibrium 5 is much more likely than equilibrium 4, which itself is more probable than equilibrium 6. As for situations where P >.995, the net loss function $\Gamma(u)$ will always be above the devaluation cost; that is, a realignment is certain.

[1] $\delta(\bar{u}_1)$ and $\delta(\bar{u}_2)$ can be read from Figure 1a.

[2] Note that $\Pr\{u_t > \bar{u}_1\}$ =0.8383 is larger than $\Pr\{u_t > \bar{u}_2\}$ =0.4505 so that equilibrium 1 is more likely to occur than equilibrium 2.

In Figure 3, finally, for an even softer Socialist party ($\theta = .01$), a single equilibrium is obtained with a lower probability of P than in Figure 2. P=0.886 will bring about the unique equilibrium (at $\bar{u}_7 = -0.010$ with $\Pr\{u_t > \bar{u}_7\} = 0.67$). There is thus a trade-off between P and the "softness" of party L, λ, in the determination of the equilibrium. Again, when P>0.886, a realignment is certain because the value of the function $\Gamma(u)$ is always above the transformed devaluation cost, K (e.g. for P − 0.90). Likewise, for sufficiently low values of the realignment cost (i.e. values below K), there is no interior solution. The threshold level of the shock is its lower bound $-\mu$ and pure discretion is optimal.

Most importantly, when devaluation expectations have risen high enough that the devaluation threshold is stuck at $-\mu$ (i.e. $\bar{u} = -\mu$) the equilibrium depreciation expectation is the same as under a free float. In fact, $\bar{u} = -\mu$ defines an additional - corner - equilibrium because the policymaker will always find it optimal to exercise discretion if private agents expect that the government will always devalue; i.e. when markets expect complete discretion; so that as $\bar{u} \rightarrow -\mu$ discretion prevails with probability one. However, if $\Gamma(-\mu) < K$ then full discretion is never optimal. For example, in Figure 1b, when P = 0.90 there is no corner equilibrium and thus there is only one possible equilibrium; whilst when P = 1, there exist three possible equilibria, including the corner equilibrium on the left axis. Likewise, note that the corner solutions on the right hand side of the Figures 1b, 2b and 3b (i.e. where u μ) correspond to an unconditional fixed exchange rate regime.

Regarding the assumption of no revaluation, it was implicitly postulated that revaluations are unattractive as long as $\Gamma(-\mu) > 0$ even when c = 0. However, for certain values of P (that is, low probabilities that party L will be elected), $\Gamma(-\mu) < 0$. For example, in the case of Figure 2b if P = 0.5, $\Gamma(-\mu) < 0$ and a revaluation would be desirable.

In summary, the introduction of a political dimension (the occurrence of an election) has shown that very high probability values that a Socialist party will be elected may ensure that a single equilibrium value of the shock, u, triggers a realignment[3], provided that the Socialist party is soft enough. Hence, extremely high values of both P and λ will guarantee the occurrence of a realignment, whatever the value of the shock. However, excessively low values of P and λ result in the exchange rate regime being abandoned only when the shock, u, reaches either of the limit values μ and $-\mu$.

Figure 1a: $\delta(u)$ for θ=0.15

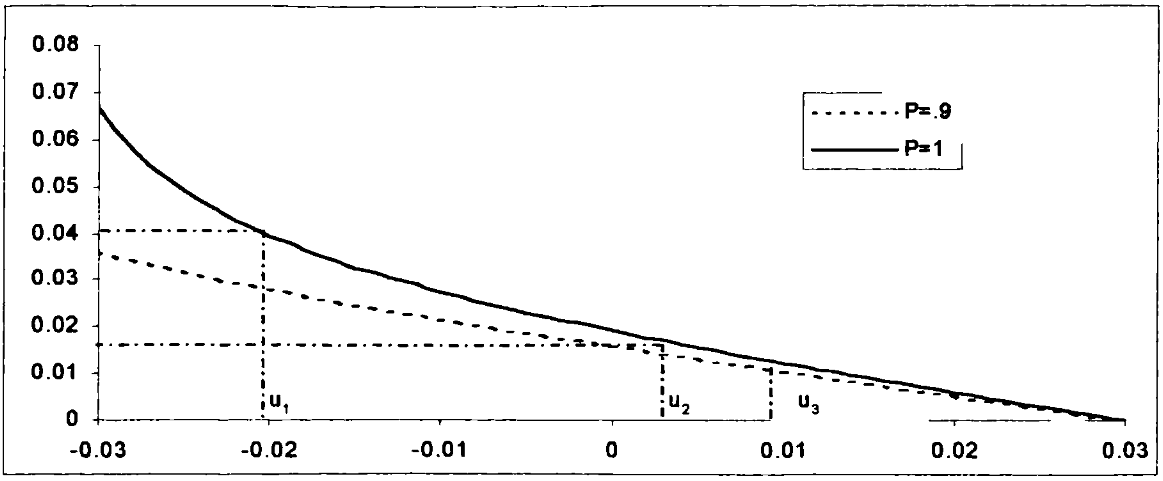
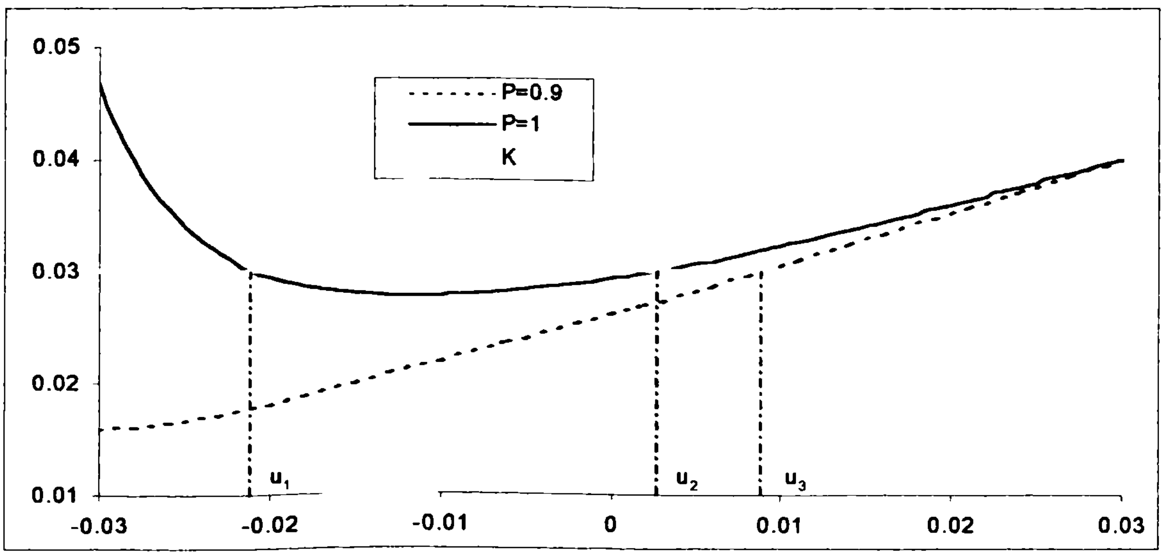


Figure 1b: $\Gamma(u)$ for θ=0.15



[3] Because the higher is the probability that the Socialist party will be elected, the higher is the expectation of a devaluation.

Figure 2: $\Gamma(u)$ for θ=0.11

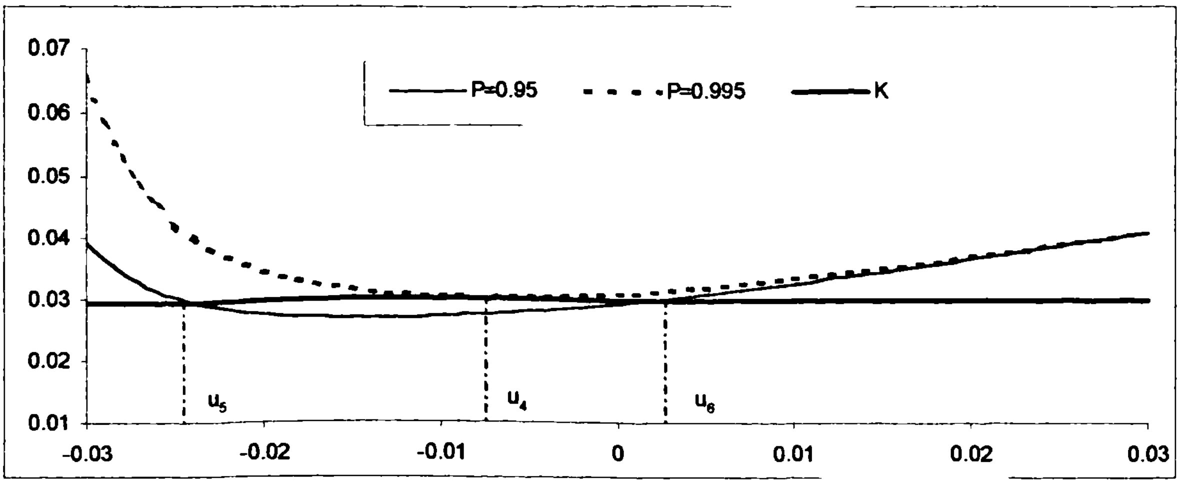
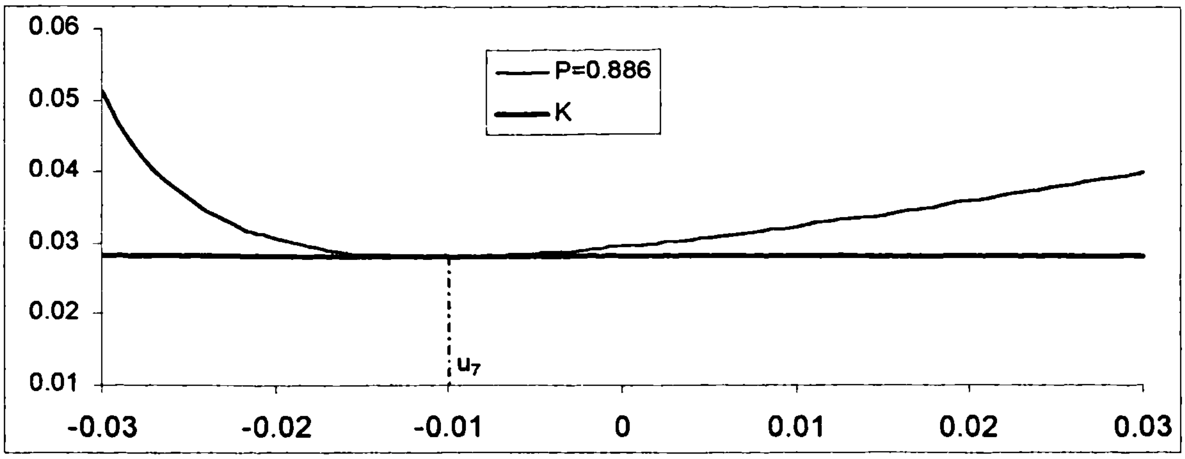


Figure 3: $\Gamma(u)$ for θ=0.01



7. 3. Empirical Estimation

According to the model presented above, devaluation expectations should be higher the softer the (Socialist) policymaker and, in an election period, the higher the probability that the Socialist party will be elected. However, given the difficulties associated with measuring "softness" and expected probabilities regarding the outcome of elections, the study examines the simpler question as to whether the market sentiment is systematically affected by the political orientation of the government and the occurrence of elections. We test our hypotheses on two currencies - the French franc and Italian lira - against which speculation has often been associated with political pressure.

7. 3. 1. Methodology

To test the model we apply the Time-Varying Transition Probability version of Hamilton's (1989) Markov Switching model, as in chapters five and six. We use two dependent variables: an index of Exchange Market Pressure (EMP) and drift adjusted devaluation expectations[4]. These dependent variables are modelled as a mixture of two normal distributions corresponding to two possible states, described as "normal" and "crisis". Switches between the tranquil and crisis regimes depend on dummy variables that are designed the political features of currency crisis models.

Appendix 7.3 provides the list of dummy variables and reviews the political background for both currencies. The sources of political variables are Keesing's Record of World Event, the Financial Times, plus data used in Eichengreen et al. (1994). For France, we follow the approach adopted by Alogoskoufis et al. (1992) and define a variable that denotes the identity of the political party in power as follows: z_t^l 1 under a Left-wing (Socialist) government, 0 when a Conservative administration is in office and 0.5 in case of Socialist-Conservative coalition. Within the sample period, the French Conservatives are in power on two occasions: between March 1979 and May 1981 as well between May 1995 and June 1996. There are two periods of so-called co-habitation: April 1986 until April 1988, and April 1993 till April 1994. There is therefore a Socialist administration between June 1981 and March 1986 and from May 1988 till March 1993. For Italy, there is no such binary split in the political system (because given the very large number of Italian political parties, no one single party achieved absolute majority in parliament) and given that the president has only limited powers and the ruling coalition was the same from 1949 until 1992, we choose an alternative variable: the change in prime minister. In practice, until 1992, the designation of the Italian prime minister occurred because political parties agreed on a particular coalition and there were seven changes in prime minister during the sample

[4] See chapters Five and Six for details on the two respective variables.

period. Hence, the dummy variable z_t^{pm} 1 when there is a change in prime minister, and zero otherwise. Finally, for both currencies, we define z_t^{elec} – 1 when there is a general election in month t, and z_t^{elec} 0 otherwise (there are 8 general elections in France and 13 in Italy from March 1979 till July 1996).

Using the notation of Chapter Four, the probability of remaining in any state i - n or c - is $p_{ii}(z_t) = \dfrac{e^{\delta_i^0 + \delta_i^1 z_t}}{1 + e^{\delta_i + \delta_i^1 z_t}}$. So, if for example one looks at the political party in power in France and δ_i^1 is positive, the probability of staying in state i will be greater the larger z_t^l. That is, a normal - or crisis - observation is more likely to be followed by a normal - or crisis - observation when the Left-wing party is in power. Conversely, if δ_i^1 is negative, the probability of staying in state i - n or c - is smaller when the Socialist party is in power. In accordance with the theoretical analysis, the time-varying parameter for transitions from the crisis state, δ_c^1, is expected to be positively related with z_t^L because a Socialist administration is presumably softer than a Conservative one. Likewise, δ_c^1 is expected to be positively influenced by dummy variables measuring elections and changes in prime minister, z_t^{elec} and z_t^{pm}, because of the uncertainty regarding both the outcome of elections and the type of new governments.

7. 3. 2. Results

As mentioned above, the methodology and dependent variables used in this chapter are the same as in Chapters Five and Six. As a result, the sample periods and specifications are also identical. Therefore, the discussion of the model specifications will not be repeated here. Tables 1a and 1b report the results obtained with the measure of exchange market pressure on the French franc over the period March 1979-July 1996 for the political party and election dummy variables, respectively. In line with the evidence presented in Chapter Five, the normal mean, μ_n, is small and negative meaning that in the normal state the French franc tends to appreciate slightly and the interest rate differential tends to decrease and foreign exchange reserves tend to grow.

The crisis mean, μ_c, is large and positive, and the crisis regime is more volatile than the normal state ($\sigma_c^2 > \sigma_n^2$). According to Table 1a, a Socialist government is positively associated with the probabilities of staying in both the crisis and normal states, since δ_n^1 and δ_c^1 are positive and statistically significant. This means that, contrary to the theoretical hypothesis, a Socialist government has a symmetrical effect on both states. The occurrence of general elections (Table 1b) does not influence the transition probabilities significantly statistically although the parameters take the expected signs.

Tables 2a and 2b present the results for the Italian index of EMP, also over the period from March 1979 until July 1996. As in Chapter Five, both tables suggest that in the normal regime the lira tends to depreciate slightly, the interest rate differential increases and reserves tend to fall (i.e. μ_n is small and positive). Conversely, when in the crisis state, the lira tends to depreciate much more, the interest rate differential becomes wider and reserves drop even more (i.e. μ_c is large and positive). As in the case of the franc, the normal state is more stable than the crisis regime. Table 2a shows the results for the dummy variable regarding changes in prime minister. Although, δ_n^1 and δ_c^1 display the expected signs, changes in prime minister do not have a statistically significant effect on the normal and crisis regimes. Table 2b provides the evidence regarding the occurrence of elections in Italy. Elections do not seem to have any statistically significant impact on any regime.

Table 3a and 3b present the results for the drift-adjusted realignment expectations regarding the French franc in the period March 1979 till January 1987. As already discussed in Chapter Six, expectation devaluations are much higher and volatile in the crisis regime than in the normal state. Table 3a concerns the political party in power. Results suggest that a Socialist government has a negative influence on the probability of remaining in either state. However, none of the transition probability parameters is statistically significant. Table 3b examines the importance of general elections. As expected, it appears that the occurrence of an election has a negative effect on the probability of remaining in the normal state (the parameter δ_n^1 is negative and statistically significant at the 10 percent level). Conversely, an election raises the probability of remaining in the crisis regime but the parameter is statistically insignificant.

Tables 4a and 4b show the results for the period from February 1987 until July 1993. As Table 1a, the results of Table 4a indicate that the dummy variable for the Socialist party has a statistically significant positive effect on the probabilities of remaining in each state, so that we cannot verify the theoretical hypothesis. Table 4b also corroborates the findings from the index of EMP (Table 1b) that the occurrence of elections does not have any significant influence on any state.

Tables 5a and 5b display the evidence about the drift-adjusted realignment expectations on the Italian lira from March 1979 till August 1992. Table 5a concerns change in prime minister. It does not provide any more conclusive results than Table 2a (for the index of EMP) since, although they have the correct signs, the two parameters δ_n^1 and δ_c^1 are statistically insignificant. Finally, Table 5b suggests that the occurrence of elections has no significant influence on the normal state but does have a significant negative effect on the crisis regime, which contradicts our theoretical predictions.

Tables 1a to 1b: French EMP 79M3 - 96M7

Table 1a: z_t^L = 1 for a Left-Wing Administration, z_t^L = 0 for Conservatives, and z_t^L – 0.5 for Co-habitation between the two parties.

μ_n	μ_c	ρ_n	σ_n^2	σ_c^2	δ_n^0	δ_n^L	δ_c^0	δ_c^L	Lik.	MSE/TP
-.0828 [-.662]	1.171* [2.74]	.2632* [3.333]	1.135* [7.856]	8.339* [4.84]	.9299 [1.211]	2.864* [2.453]	-1.031 [-.973]	4.148* [2.79]	-193.9	3.3544 .1644

Table 1b: z_t^{elec} = 1 when the elections take place, z_t^{elec} – 0 otherwise.

μ_n	μ_c	ρ_n	σ_n^2	σ_c^2	δ_n^0	δ_n^{elec}	δ_c^0	δ_c^{elec}	Lik.	MSE/TP
-.0751 [-.616]	1.271* [2.64]	.247* [3.123]	1.171* [6.477]	8.829* [4.35]	2.555* [4.491]	-1.509 [-.737]	1.004 [1.39]	4.933 [.365]	-198.2	3.3396 .1294

Tables 2a to 2b: Italian EMP 79M3 - 1996M7

Table 2 a: $z_t^{pm} = 1$ when change in Prime minister, $z_t^{pm} = 0$ when no change in PM.

μ_n	μ_c	ρ_n	σ_n^2	σ_c^2	δ_n^0	δ_n^{pm}	δ_c^0	δ_c^{pm}	Lik.	MSE/TP
.0667 [1.43]	.5578* [2.38]	.5396* [7.12]	.0770* [3.96]	1.828* [10.6]	2.705* [6.82]	-.8793 [-.535]	.809** [1.73]	.2592 [.140]	65.495	.4499 .0963

Table 2b: $z_t^{elec} = 1$ when the elections take place, $z_t^{elec} = 0$ otherwise.

μ_n	μ_c	ρ_n	σ_n^2	σ_c^2	δ_n^0	δ_n^{elec}	δ_c^0	δ_c^{elec}	Lik.	MSE/TP
.0699 [1.48]	.5485* [2.39]	.5478* [7.422]	.0783* [4.05]	1.849* [10.5]	2.682* [6.76]	2.055 [.242]	1.06** [1.94]	-1.646 [-1.00]	65.96	.4549 .0988

Tables 3a to 3b: French Drift Adjusted Devaluation Expectations: 79M3-87M1

Table 3a: $z_t^L = 1$ for a Left-Wing Administration

μ_n	μ_c	ρ_n	σ_n^2	σ_c^2	δ_n^0	δ_n^L	δ_c^0	δ_c^l	Lik.	MSE/TP
1.3434 [1.23]	22.81* [6.94]	.9412* [17.8]	4.227* [11.8]	107.4* [5.18]	3.524* [3.604]	-.7729 [-.657]	2.9575 [.842]	-2.325 [-.643]	-157.4	64.020 .77347

Table 3b: $z_t^{elec} = 1$ when the elections take place, $z_t^{elec} = 0$ otherwise.

μ_n	μ_c	ρ_n	σ_n^2	σ_c^2	δ_n^0	δ_n^{elec}	δ_c^0	δ_c^{elec}	Lik.	MSE/TP
1.3908 [1.34]	23.29* [8.05]	.9380* [17.3]	4.274* [11.7]	102.3* [5.19]	3.235* [5.678]	-2.51** [-1.77]	.6103 [.963]	5.0135 [.300]	-156.3	67.126 .78079

Tables 4a to 4b: French Drift Adjusted Devaluation Expectations: 87M2 - 93M7

Table 4 a: $z_t^L = 1$ for a Left-Wing Administration.

μ_n	μ_c	ρ_1	ρ_2	ρ_3	σ_n^2	σ_c^2	δ_n^0	δ_n^L	δ_c^0	δ_c^L	Lik.	MSE/TP
.3828 [.388]	5.46* [3.9]	1.40* [16.5]	-.69* [-5.7]	.16** [1.84]	.828* [10.0]	9.16* [3.83]	1.754 [1.52]	2.9** [1.87]	-3.45 [-1.1]	8.5** [1.85]	-58.5	11.17 .1167

Table 4b: $z_t^{elec} = 1$ when the elections take place, $z_t^{elec} = 0$ otherwise.

μ_n	μ_c	ρ_1	ρ_2	ρ_3	σ_n^2	σ_c^2	δ_n^0	δ_n^{elec}	δ_c^0	δ_c^{elec}	Lik.	MSE/TP
.3821 [.42]	4.59* [3.5]	1.38* [12.3]	-.77* [4.2]	.261* [2.01]	.869* [9.61]	11.3* [3.89]	4.34* [2.38]	699.4 [.254]	3.055 [1.58]	375.6 [.027]	-61.7	11.21 .1512

Tables 5a to 5b: Italian Drift Adjusted Devaluation Expectations: 79M3 - 92M8

Table 5b: $z_t^{pm} = 1$ when Change in Prime Minister, $z_t^{pm} = 0$ when no Change.

μ_n	μ_c	ρ_1	σ_n^2	σ_c^2	δ_n^0	δ_n^{pm}	δ_c^0	δ_c^{pm}	Lik.	MSE/TP
4.69* [3.29]	6.09* [3.90]	.945* [36.9]	.675* [11.9]	3.08* [10.1]	3.59* [2.86]	-2.63 [-1.2]	2.69* [3.87]	7.079 [.056]	-132.5	71.33 .3385

Table 5b: $z_t^{elec} = 1$ when the elections take place, $z_t^{elec} = 0$ otherwise.

μ_n	μ_c	ρ_1	σ_n^2	σ_c^2	δ_n^0	δ_n^{elec}	δ_c^0	δ_c^{elec}	Lik.	MSE/TP
3.97* [2.02]	4.63* [2.29]	.957* [40.3]	.658* [11.2]	3.03* [11.4]	4.70* [3.63]	-11.0 [-.79]	3.28* [4.78]	-3.4** [-1.9]	-128.3	71.47 .3831

7. 4. Conclusions

The analysis has showed that that the higher the probability values that a Socialist party will be elected the more likely it is that there will be a single equilibrium, i.e. a realignment. Nonetheless there remain circumstances in which multiple equilibria occur. That is, there is a middle ground in which the parameters of the system - including the probability of the L party being elected - do not prompt either an impossible or an inevitable realignment. In this case, there may or may not be an abrupt change in expectations from a situation where a devaluation is viewed as impossible to one in which it is seen as almost certain and the policymaker is forced to realign.

As far as the empirical evidence on political determinants of currency crises in France and Italy is concerned, the only theoretically consistent and statistically significant evidence regards the drift adjusted realignment expectations for the French franc in the 1979-1987 period, for which it was found that elections have a negative effect on the probability of remaining in the normal state. We interpret the lack of conclusive evidence to the difficulty to proxy the many different factors in play; i.e. the effects of politics on economic policy making, the consequences of economic policies on market expectations and the repercussions of expectations on financial market outcomes. Moreover, a government may change economic policy, say, between expansionary and tight monetary and fiscal policies in the course of its mandate. Then, using a dummy variable for the political nature of the government is not satisfactory and a better approach would be to construct a variable for changes in policy preferences.

Appendix 7. 1. Political Business Cycles

Given that the private sector is aware of the strategy of each party: $\hat{\Pi}_t^L = (e_t - e_{t-1}) = \lambda(w_t - e_{t-1}) + \lambda(y^*/\alpha) + \lambda(u_t/\alpha)$ for the Left-Wing party and $\hat{\Pi}_t^C = (e_t - e_{t-1}) = 0$ for the Conservative party, it will set wages accordingly, so that:

• if party L is elected at time t+kN:

$$w_{t+i+kN} = E_{t+i+kN}(e_t) = e_{t+i+kN-1} + \lambda(w_{t+i+kN} - e_{t+i+kN-1}) + \lambda E_{t+i+kN-1}(u_{t+i+kN}/\alpha) + \lambda(y^*/\alpha)$$

where k=0, 1, ...; i=1,....,N-1; or, since $E_{t+kN-1}(u_{t+kN}) = 0$;

$$\Pi^e_{t+i+kN} = (w_{t+i+kN} - e_{t+i+kN-1}) = \left[\frac{\lambda}{(1-\lambda)}(y^*/\alpha)\right] \quad \text{(A1)}$$

• if party C is elected at time t+kN:

$$\Pi^e_{t+i+kN} = (w_{t+i+kN} - e_{t+i+kN-1}) = 0 \quad \text{(A2)}$$

where k=0, 1, ...; i 1,....,N-1;

• if t is an electoral year:

$$\Pi^e_{t+kN} = PE_{t+kN-1}(\Pi^L_{t+kN}) + (1-P)E_{t+kN-1}(\Pi^C_{t+kN}) = P\left[\frac{\lambda}{(1-\lambda)}(y^*/\alpha)\right] \quad \text{(A3)}$$

k 0, 1, ...

Several propositions can be derived from the output equation $y_t = \alpha(e_t - w_t) - u_t$, and equations (A1) to (A3):

1. In the first period of a Socialist government, there is unexpected inflation and thus output growth is:

$$y_t^L = (1-P)\left(\frac{\lambda}{(1-\lambda)}y^*\right) - u_t \quad \text{(A4)}$$

2. If the Conservatives are is elected at time t, there is a recession in the first period:

$$y_t^C = -P\left(\frac{\lambda}{(1-\lambda)}y^*\right) - u_t \quad \text{(A5)}$$

3. The lower is P, the higher is the output growth in the first period if party L is in office and the smaller is the recession determined by the Conservatives if elected (and vice versa, the higher is P). In other words, in both administrations, the less expected is the policy, the stronger are its real effects.

In the remaining N-1 periods of both governments, there is no policy surprise and output growth will be the same regardless of which party holds power. Hence, combining (7) and (9) gives the equilibrium depreciation if the Socialist party is in office in period $t+kN$:

$$e_{t+kN} - e_{t+kN-1} = \lambda(u_{t+kN} / \alpha) + \lambda(y^* / \alpha) \tag{A6}$$

Similarly, if party C is in office in period t+kN, $e_{t+kN} - e_{t+kN-1} = 0$

That is, the time consistent rate of inflation is higher under an L government than under a Conservative government, first, because optimal inflation is higher for party L than for party C; and secondly, because party L has more incentives to devalue.

APPENDIX 7. 2. Derivation of the Equilibria

- There is one unique equilibrium of P, the probability of the Left-Wing party being elected, whenever:

$$P = P_1 = \left[\left(\lambda + \frac{\lambda y^*}{\mu}\right) + \sqrt{\left(\lambda + \frac{\lambda y^*}{\mu}\right)^2 - \frac{2c\lambda}{\mu^2}}\right] \times \left[\frac{\mu^2}{c\lambda}\right]$$

$$\text{or, } P = P_2 = \left[\left(\lambda + \frac{\lambda y^*}{\mu}\right) - \sqrt{\left(\lambda + \frac{\lambda y^*}{\mu}\right)^2 - \frac{2c\lambda}{\mu^2}}\right] \times \left[\frac{\mu^2}{c\lambda}\right]$$

In other words, when P– P1, or P2, the curve representing the function $\Gamma(\bar{u})$ is tangent to the transformed threshold devaluation cost curve, K, in its minimum for some unique value of the shock, $\bar{u} = \left[\frac{-P}{\mu}\sqrt{\frac{\lambda c}{2}} + 1\right] \times \left(\frac{2\mu}{P\lambda}\right)$.

- There is no possible equilibrium whenever P∈]P1, P2[.

In this case the curve representing the function $\Gamma(\bar{u})$ is always above the transformed threshold devaluation cost curve, K, and therefore a devaluation is bound to take place.

- There are two possible equilibrium values of the shock, u:

$$\bar{u}_1 = \left[\frac{-P}{\mu}\sqrt{\frac{\lambda c}{2}} + 1 - \sqrt{\frac{\lambda c}{2\mu^2}P^2 - \left(\frac{\lambda}{\mu}y^* + \lambda\right)P + 1}\right] \times \left(\frac{2\mu}{P\lambda}\right) \qquad \text{and}$$

$$\bar{u}_1 = \left[\frac{-P}{\mu}\sqrt{\frac{\lambda c}{2}} + 1 + \sqrt{\frac{\lambda c}{2\mu^2}P^2 - \left(\frac{\lambda}{\mu}y^* + \lambda\right)P + 1}\right] \times \left(\frac{2\mu}{P\lambda}\right)$$

whenever P1<P< P2 , which means that any random event could provoke a shift from an equilibrium where a realignment is not expected to one in which devaluation expectations are very high.

Note however that there may be one single value of P bringing about a unique equilibrium value of u. That is, when $\lambda_s = \dfrac{2c}{2y^*\mu + (y^*)^2 + \mu^2}$ there is a single root value of P, $P_s = \lambda_s + \dfrac{\lambda_s y^*}{\mu} + \dfrac{\mu^2}{c\lambda_s}$ that determines the single equilibrium value of the shock♣. Note also, that there is no feasible unique equilibrium u value whenever $\lambda \in]0,\ \lambda_s[$. In other words, P1 and P2 only exist where $\lambda > \lambda_s$.

In all circumstances, the situation where $\bar{u} = -\mu$ or μ are themselves always equilibrium points.

♣ Here the case where λ 0, that would be consistent with a unique value of P, P 0, for which u is unique is obviously excluded.

APPENDIX 7. 3.

Table A1. Dummy Variables used for France

	z^J_t	z^{elec}_t		z^J_t	z^{elec}_t		z^J_t	z^{elec}_t		z^J_t	z^{elec}_t		z^J_t	z^{elec}_t
M-79	0	0	S-82	1	0	M-86	1	1	S-89	1	0	M-93	0	1
A-79	0	0	O-82	1	0	A-86	0	0	O-89	1	0	A-93	0.5	0
M-79	0	0	N-82	1	0	M-86	0.5	0	N-89	1	0	M-93	0.5	0
J-79	0	0	D-82	1	0	J-86	0.5	0	D-89	1	0	J-93	0.5	0
J-79	0	0	J-83	1	0	J-86	0.5	0	J-90	1	0	J-93	0.5	0
A-79	0	0	F-83	1	0	A-86	0.5	0	F-90	1	0	A-93	0.5	0
S-79	0	0	M-83	1	1	S-86	0.5	0	M-90	1	0	S-93	0.5	0
O-79	0	0	A-83	0	0	O-86	0.5	0	A-90	1	0	O-93	0.5	0
N-79	0	0	M-83	1	0	N-86	0.5	0	M-90	1	0	N-93	0.5	0
D-79	0	0	J-83	1	0	D-86	0.5	0	J-90	1	0	D-93	0.5	0
J-80	0	0	J-83	1	0	J-87	0.5	0	J-90	1	0	J-94	0.5	0
F-80	0	0	A-83	1	0	F-87	0.5	0	A-90	1	0	F-94	0.5	0
M-80	0	0	S-83	1	0	M-87	0.5	0	S-90	1	0	M-94	0.5	0
A-80	0	0	O-83	1	0	A-87	0.5	0	O-90	1	0	A-94	0.5	0
M-80	0	0	N-83	1	0	M-87	0.5	0	N-90	1	0	M-94	0.5	0
J-80	0	0	D-83	1	0	J-87	0.5	0	D-90	1	0	J-94	0.5	0
J-80	0	0	J-84	1	0	J-87	0.5	0	J-91	1	0	J-94	0.5	0
A-80	0	0	F-84	1	0	A-87	0.5	0	F-91	1	0	A-94	0.5	0
S-80	0	0	M-84	1	0	S-87	0.5	0	M-91	1	0	S-94	0.5	0
O-80	0	0	A-84	1	0	O-87	0.5	0	A-91	1	0	O-94	0.5	0
N-80	0	0	M-84	1	0	N-87	0.5	0	M-91	1	0	N-94	0.5	0
D-80	0	0	J-84	1	0	D-87	0.5	0	J-91	1	0	D-94	0.5	0
J-81	0	0	J-84	1	0	J-88	0.5	0	J-91	1	0	J-95	0.5	0
F-81	0	0	A-84	1	0	F-88	0.5	0	A-91	1	0	F-95	0.5	0
M-81	0	0	S-84	1	0	M-88	0.5	0	S-91	1	0	M-95	0.5	0
A-81	0	1	O-84	1	0	A-88	0.5	1	O-91	1	0	A-95	0.5	1
M-81	0	1	N-84	1	0	M-88	0	0	N-91	1	0	M-95	0	1
J-81	1	0	D-84	1	0	J-88	1	0	D-91	1	0	J-95	0	0
J-81	1	0	J-85	1	0	J-88	1	0	J-92	1	0	J-95	0	0
A-81	1	0	F-85	1	0	A-88	1	0	F-92	1	0	A-95	0	0
S-81	1	0	M-85	1	0	S-88	1	0	M-92	1	0	S-95	0	0
O-81	1	0	A-85	1	0	O-88	1	0	A-92	1	0	O-95	0	0
N-81	1	0	M-85	1	0	N-88	1	0	M-92	1	0	N-95	0	0
D-81	1	0	J-85	1	0	D-88	1	0	J-92	1	0	D-95	0	0
J-82	1	0	J-85	1	0	J-89	1	0	J-92	1	0	J-96	0	0
F-82	1	0	A-85	1	0	F-89	1	0	A-92	1	0	F-96	0	0
M-82	1	0	S-85	1	0	M-89	1	0	S-92	1	0	M-96	0	0
A-82	1	0	O-85	1	0	A-89	1	0	O-92	1	0	A-96	0	0
M-82	1	0	N-85	1	0	M-89	1	0	N-92	1	0	M-96	0	0
J-82	1	0	D-85	1	0	J-89	1	0	D-92	1	0	J-96	0	0
J-82	1	0	J-86	1	0	J-89	1	0	J-93	1	0	J-96	0	0
A-82	1	0	F-86	1	0	A-89	1	0	F-93	1	0			

Table A1. Dummy Variables used for Italy

		z_t^{elec}			z_t^{elec}			z_t^{elec}			z_t^{elec}			z_t^{elec}
M-79	0	0	S-82	0	0	M-86	0	0	S-89	0	0	M-93	0	0
A-79	1	0	O-82	0	0	A-86	0	0	O-89	0	0	A-93	0	1
M-79	0	0	N-82	0	1	M-86	0	0	N-89	0	0	M-93	0	0
J-79	0	0	D-82	0	0	J-86	0	0	D-89	0	0	J-93	0	0
J-79	0	0	J-83	0	0	J-86	0	0	J-90	0	0	J-93	0	0
A-79	0	0	F-83	0	0	A-86	0	0	F-90	0	0	A-93	0	0
S-79	0	0	M-83	0	0	S-86	0	0	M-90	0	0	S-93	0	0
O-79	0	0	A-83	1	0	O-86	0	0	A-90	0	0	O-93	0	0
N-79	0	0	M-83	0	0	N-86	0	0	M-90	0	0	N-93	0	0
D-79	0	0	J-83	0	1	D-86	0	0	J-90	0	0	D-93	0	0
J-80	0	0	J-83	0	0	J-87	0	0	J-90	0	0	J-94	0	0
F-80	0	0	A-83	0	0	F-87	0	0	A-90	0	0	F-94	0	0
M-80	0	0	S-83	0	0	M-87	0	0	S-90	0	0	M-94	0	0
A-80	0	0	O-83	0	0	A-87	0	1	O-90	0	0	A-94	1	1
M-80	0	0	N-83	0	0	M-87	0	0	N-90	0	0	M-94	0	0
J-80	0	0	D-83	0	0	J-87	1	1	D-90	0	0	J-94	0	0
J-80	0	0	J-84	0	0	J-87	0	0	J-91	0	0	J-94	0	0
A-80	0	0	F-84	0	0	A-87	0	0	F-91	0	0	A-94	0	0
S-80	0	0	M-84	0	0	S-87	0	0	M-91	0	0	S-94	0	0
O-80	0	1	A-84	0	0	O-87	0	0	A-91	0	0	O-94	0	0
N-80	0	0	M-84	0	0	N-87	0	0	M-91	0	0	N-94	0	0
D-80	0	0	J-84	0	0	D-87	0	0	J-91	0	0	D-94	0	0
J-81	0	0	J-84	0	0	J-88	0	0	J-91	0	0	J-95	0	1
F-81	0	0	A-84	0	0	F-88	0	0	A-91	0	0	F-95	0	0
M-81	0	1	S-84	0	0	M-88	0	1	S-91	0	0	M-95	0	0
A-81	0	0	O-84	0	0	A-88	0	0	O-91	0	0	A-95	0	0
M-81	0	0	N-84	0	0	M-88	0	0	N-91	0	0	M-95	0	0
J-81	0	0	D-84	0	0	J-88	0	0	D-91	0	0	J-95	0	0
J-81	0	0	J-85	0	0	J-88	0	0	J-92	0	0	J-95	0	0
A-81	0	0	F-85	0	0	A-88	0	0	F-92	0	0	A-95	0	0
S-81	0	0	M-85	0	0	S-88	0	0	M-92	0	0	S-95	0	0
O-81	0	0	A-85	0	0	O-88	0	0	A-92	1	0	O-95	0	0
N-81	0	0	M-85	0	0	N-88	0	0	M-92	0	0	N-95	0	0
D-81	0	0	J-85	0	0	D-88	0	0	J-92	0	1	D-95	0	0
J-82	0	0	J-85	1	0	J-89	0	0	J-92	0	0	J-96	0	0
F-82	0	0	A-85	0	0	F-89	0	0	A-92	0	0	F-96	0	0
M-82	0	0	S-85	0	0	M-89	0	0	S-92	0	0	M-96	0	0
A-82	0	0	O-85	0	0	A-89	0	0	O-92	0	0	A-96	1	1
M-82	0	0	N-85	0	0	M-89	0	1	N-92	0	0	M-96	0	0
J-82	0	0	D-85	0	0	J-89	0	0	D-92	0	0	J-96	0	0
J-82	0	0	J-86	0	0	J-89	0	0	J-93	0	0	J-96	0	0
A-82	0	0	F-86	0	0	A-89	0	0	F-93	0	0			

French Political background

In the early stage of the EMS, the Socialist government (elected in May 1981) pursues clearly expansionary policies and shows very little commitment to the fixed exchange rate peg. A drastic change of stance however takes place in June 1982 and is reinforced in March 1983 when the French government adopts far tighter fiscal and monetary policies and, despite the high cost of unemployment, there is no realignment for a three-year period.

With the arrival to power of the Conservatives - with the Socialist Mitterrand still President - between 1986 and 1988, the strong currency reputation is strengthened and the continuity in the exchange rate policy ensures a strong franc. In March and April 1987, the French government encounters co-habitation problems. In November 1987, the franc suffers a period of pressure despite substantial intervention by the Banque de France, as the German mark benefits from the dollar's decline. Controversy begins within the governing parties over domestic policies. In April 1988, due to the uncertainty about the outcome of the elections in France, the franc weakens in May prior to President Mitterrand's re-election. In May, the socialists return to power and reassert that the franc will not be devalued in the future despite the problem of unemployment and slow growth. In October 1988, tensions emerge again in the foreign exchange markets and the Banque de France intervenes in support of the franc. Although the left wing parties made some minor gains in cantonal elections, the Prime Minister, M. Rocard comes under increasing pressure from industrial unrest.

In January 1993, the FRF/DEM rate is at the limit of the maximum allowed. It then fluctuates violently due to uncertainty about the March election. In the run-up to the March 1993 elections, there is uncertainty not only about the attitude of the new government towards monetary and fiscal issues but also about the reform of the Banque de France in line with the Maastricht treaty. However, the political fears that characterise the pre-election debate about the future course of the French monetary policy are dissipated. March 1993 sees the election victory for the centre right. Mitterrand names Balladur Prime Minister, a second period of cohabitation starts.

Among the first measures adopted by the new government, the Budget and the reform of the Banque de France give clear signs that the government is committed to the Maastricht Treaty*. New uncertainty emerges however about the economic feasibility of the high level of interest rates in face of the expectations of high unemployment and low GDP growth and the government emphasis on low inflation. In fact, the estimated political cost cumulates steadily from March 1993 and the new cabinet, new budget and the reform of the Banque de France only give the franc a brief respite. Finally, the Banque de France's inability to match the German reduction in interest rates at the beginning of July is quickly interpreted as a sign of weakness so that the situation worsens in the second half of July with the ultimate enlargement of the band on August 1st.

In January 95 there is a sharp fall in the franc as the market is very sensitive to political rumours before the coming elections in the spring. In May 95 Chirac, of the centre right, is elected President of the Republic in the second round of the elections. In October 1995 new tensions emerge against the franc. The Banque de France is forced to raise its emergency Repo rate. Continuing pressure on the markets prompts President Chirac to make a televised announcement to which the market finally reacts favourably.

The Italian Political Background

The main special feature of the Italian government system until 1992 is its extraordinary stability. The electoral system of proportional representation facilitates the proliferation of political parties which makes it virtually impossible for any one party to achieve an absolute majority in parliament, forcing the leading party to negotiate with others to form a government. Until 1992, the president in practice has no decisive role and new electoral system of 1992 actually makes the role of the president even less decisive. Therefore the most important characteristic of the Italian political system from 1949 till 1992, is that the Christian Democrats are the permanent leading party in

* Moreover two strong supporters of the process of European integration are appointed as Finance and European Affairs ministers in the new cabinet.

power and the Italian Communist Party - apart from short periods in which it supports governments of "national unity" - is permanently in opposition .

The April 1992 general election and the investigations into illicit party financing have the effect of an earthquake on the political scene. The series of corruption scandals marks the end of the most stable political system in Europe. It results in the defeat of the parties that had ruled Italy since the Second World War and in particular the Christian Democrats and Socialists, which formed the backbone of the ruling coalition. The new government headed by Amato remains in power until the referendum of April 18-19 1993. The government enacts several important measures to correct public finances, although rather late in day, after the devaluation of the lira and the exit from the ERM.

The period 1992-1994 represents the most important discontinuity in the history of the political system of post-war Italy. In 1994, Romano Prodi – a catholic technocrat becomes the PDS, a party dominated by the left-of-centre 'progressive' coalition and, after the elections of 1996, the Prime minister of Italy's first left-wing coalition. The Forza Italia created by Berlusconi in January 1994 wins the largest share of the vote on 27/03/94 and Berlusconi becomes prime minister. However Berlusconi is able to maintain his right-wing tripartite government only for seven months from May to September 1994. The democratic party of the left led by Massimo D'Alema, becomes the most important force supporting the government of 'technocrats' headed by Lamberto Dini, Prime minister from January to December 1995. D'Alema proceeds by forming the Olive Tree alliance led by the catholic economist Romano Prodi who takes over the government after Dini▲.

Note that there was a succession of 13 governments in the period

▲ The victory of the left in the 1996 elections came 49 years after its expulsion from government.

Chapter 8
Conclusions

8. 1. Summary and Conclusions

Since the inception of the ERM, the French franc and the Italian lira have been subject to periodic crises which have led to devaluations, reserves losses, interest rate hikes and, in the case of Italy, a temporary exit from the ERM. The overall objective of this study was to examine the hypothesis that these incidents were caused by the deterioration of identifiable economic variables and observable political events.

The non-linear econometric methodology employed characterised the evolution of the foreign exchange markets as a mixture of calm and agitated cycles. Results validated the choice of methodology inasmuch as the identification of the crisis/tranquil episodes did not differ across periods and across measures of speculative pressure.

Indeed, modelling of the shifts between tranquil (low speculative pressure) and crisis (high speculative pressure) episodes has provided an adequate framework within which to examine defined hypotheses. By contrast to the existing literature, it was found that weak fundamentals play a meaningful role in the unfolding of currency crises. Significant effects on the French index of exchange market pressure were discovered for unemployment, trade balance, competitiveness, inflation and output growth. In the case of Italy, debt as well as -to a lesser extent- the ratio of M2 to reserves, output growth and inflation exert a significant influence on the state of the index. These effects are in some cases lagged by one or two months. With the exception of conclusive results for the franc devaluation expectations in the period 1987 to 1993, findings on the French and Italian realignment expectations are comparatively less robust. Ultimately, it is difficult to generalise the results but it appears that the index of exchange market pressure outperformed the drift-adjusted realignment expectations.

Indeed, it was remarked that the significant indicators of regime switches were generally different for the two alternative measures of speculative pressure (in particular for Italy). This brings us back to the issue of the definition and measure of currency crisis and suggests that it may be preferable to choose the definition that suits one's objectives or to evaluate the performance of different measures. For example, monetary authorities and international institutions[1] presumably want to prevent currency crises and, therefore, may extend the concept of crisis to *both* successful and failed attacks. From their perspective, false alarms are not a substantial problem and, therefore, an index of exchange market pressure and estimates of devaluation expectations may be appropriate. Investors, by contrast, need to limit their exposure and predict crises more accurately and therefore may prefer to use a measure of actual devaluation in order to avoid false alarms.

A comparison of the results for France and Italy also corroborated our initial belief that currency crises are country specific. First, the determinants of the shifts from the tranquil and crisis regimes were distinct for the two currencies under investigation. Secondly, although the methodology used in the thesis is similar to that of Martinez (1999), evidence of economic channels of influence on currency crises is stronger in our single-country investigation of the French franc and Italian lira than in Martinez' s study of all EMS currencies together. This may indeed explain the relative lack of robustness of multi-country studies. Substantial differences in the results were also found across sample periods, suggesting potential sample bias. Despite that, findings regarding the channels of influence on currency crises for alternative sample periods are consistent with the consensus view that currency credibility is not constant over time.

An *a priori* view of the thesis was that it may be possible to distinguish the empirical relevance of the two generations of currency crisis models. This however proved a difficult task since the significant variables for the French franc and Italian lira were a mixture of variables consistent with both generations of currency crisis models. It was initially assumed, for example, that unemployment and GDP growth are more relevant in second-generation models, whilst trade balance, inflation, debt and reserves are associated with balance-of-payments models. Ultimately, our inference suggests that the two types of models may be complements rather than substitutes.

As far as the methodological implications are concerned, the analysis has shown that it is possible to measure speculative pressure and identify accurately tranquil and crisis episodes in the ERM by modelling an index of exchange market pressure or drift-adjusted realignment

[1] The IMF in particular.

expectations, as a process drawn from two distributions. Moreover, significant links were found between specific macroeconomic variables and speculative pressure, in contrast to some previous works that failed to discover any significant links. Therefore, given the relatively successful results and the fact that the methodology employed avoids most of the problems encountered with existing approaches, it would appear fruitful to apply a regime switching technique to various measures of currency crisis, use a broad variety of exogenous variables, and focus on individual countries.

A number of policy recommendations also follow from the evidence obtained in the empirical part of the thesis. First, findings for Italy demonstrated that imprudent fiscal and monetary policies combined with unstable fundamentals are most likely to trigger speculative attacks. Conversely, the inference on the French franc suggested that, during speculative waves, a country with healthy fundamentals can become victim of unsustainable pressure. In this respect, responsibility for currency crises cannot be placed entirely on the mismanagement of an economy. Overall, the results may provide a case for the elimination of national currencies and bring support for economic and monetary union, although it may be that, as argued by Kenen (1995b), the ERM crises simply showed that "adjustability should not be sacrificed to credibility".

Whilst most models of currency crisis assume that the government stays in power forever, the analysis presented in Chapter 7 took into account the role of political events in determining the model equilibria. In this context, the optimisation problem and the formulation of devaluation expectations were made more uncertain and therefore more realistic and satisfactory. It was not possible to verify empirically the model's predictions that elections, changes in Prime Minister and "soft" governments are positively associated with currency crises.

8. 2. Suggestions for Further Research

There are a number of potential extensions to the thesis. First, the inclusion of other, new, indicators would potentially improve our understanding of currency crises. They may include more economic variables, but also institutional factors such as the process of European monetary integration and the degree of central bank independence, which are known to play a pivotal role in the determination of currency credibility. Moreover, it was suggested that one of the reasons for the poor results regarding political channels of influence, is the use of dummy variables. Although efforts to refine the analysis may still be limited by unsatisfactory measures of political factors, a possible extension is to account for the very fact that the utility function of a government may change[2], and thereby exert some influence on the exchange rate. Indeed, the policy stance of a government and the process of policymaking have direct effects on whether a vulnerable currency will be subject to a crisis. The development of this point may involve constructing dummy variables based on survey data and information from newspapers and specialised magazines.

Furthermore, the heterogeneity of investors' expectations and the possibility of herd behaviour deserve to be explored. This line of research is characterised by the introduction of (microeconomic) concepts such as rational or irrational herding. The idea is that agents all act alike as a result of either principal-agent problems, reputation considerations[3] or information acquisition (cascades)[4]. Non-rational behaviour is also related to models of noise, naïve or chartist trader, when trading deviates from a perfectly rational scheme of behaviour[5]. For example, Topol's (1991) theory of mimetic contagion shows how stock market participants trace out information about fundamentals from the bid and ask prices of others. Technically, it might therefore be feasible to extract indicators of market sentiment from, for example, asset prices or developments in other countries (contagion).

Another potential extension would be to forecast currency crises out of sample. However, predicting the vulnerability of an economy to a currency crisis is likely to involve many more issues than can be summarised in any set of observable variables. The timing of crises may just be unpredictable insofar as they only reflect changes in market opinions. Indeed, from an empirical perspective, purely self-fulfilling shifts in market beliefs and switches in expectations resulting from a fundamental shock cannot readily be isolated. This might explain the inconclusive evidence on forecasting currency crises based on quantifiable variables such as interest rate differentials, option prices or survey data on exchange rate forecasts.

[2] For example, the relative weight a government gives to inflation and unemployment may change over time.
[3] The idea is that, whatever the outcome of a speculative operation, if a trader follows the crowd, he will either make the same profit as the others, or lose as the others, but either way, he will preserve his reputation.
[4] The cascade story is described in Banerjee (1992), Bickhchandani et al (1992), Shiller (1995).

An important issue that deserves further study, both theoretically and empirically, is contagion. Although there is a growing body of literature on the subject, the modelling of contagion remains in its infancy. In the context of the ERM, a possible way to explain contagion is to incorporate channels through which the political resolution of any ERM member to maintain the parity of its currency fixed affects the perceived values of other currencies. The idea is to account for the possibility that a devaluation within the ERM lowers the perceived probability of transition to EMU and thus the probability that other ERM members will remain committed to maintain the existing parities[6]. Krugman (1998) relates crisis contagion to the fact that once a country has abandoned a fixed peg, agents will expect other "culturally-close" governments to do the same. He also suggests that the political commitment to the ERM might have shown some element of herding in the sense that once the UK and Italy had opted out, it was less costly politically for Sweden to follow suit. In terms of modelling, the channel through which the devaluation of an ERM currency raises the probability of devaluation of other currencies could be captured by a fall in the benefit of defending these other currencies (or a decrease in the cost of realignment).

[5] For works on noise and technical trading see, for example, Dominguez (1986), Froot & Frankel (1990), Froot & Thaler (1990) and Taylor & Allen (1992).

[6] This follows from the fact that transition to EMU is, according to the Maastricht treaty, partly conditional on no realignment in the two years before entry.

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